

PHOTOGRAPHIC HANDY-BOOKS.

NO. I.

INSTRUCTION

IN

PHOTOGRAPHY.

BY

CAPTAIN W. DE W. ABNEY, R.E., F.R.S.

LONDON:

PIPER & CARTER, 15, GOUGH SQUARE,
FLEET STREET, E.C.

1879.

[FOURTH EDITION.]

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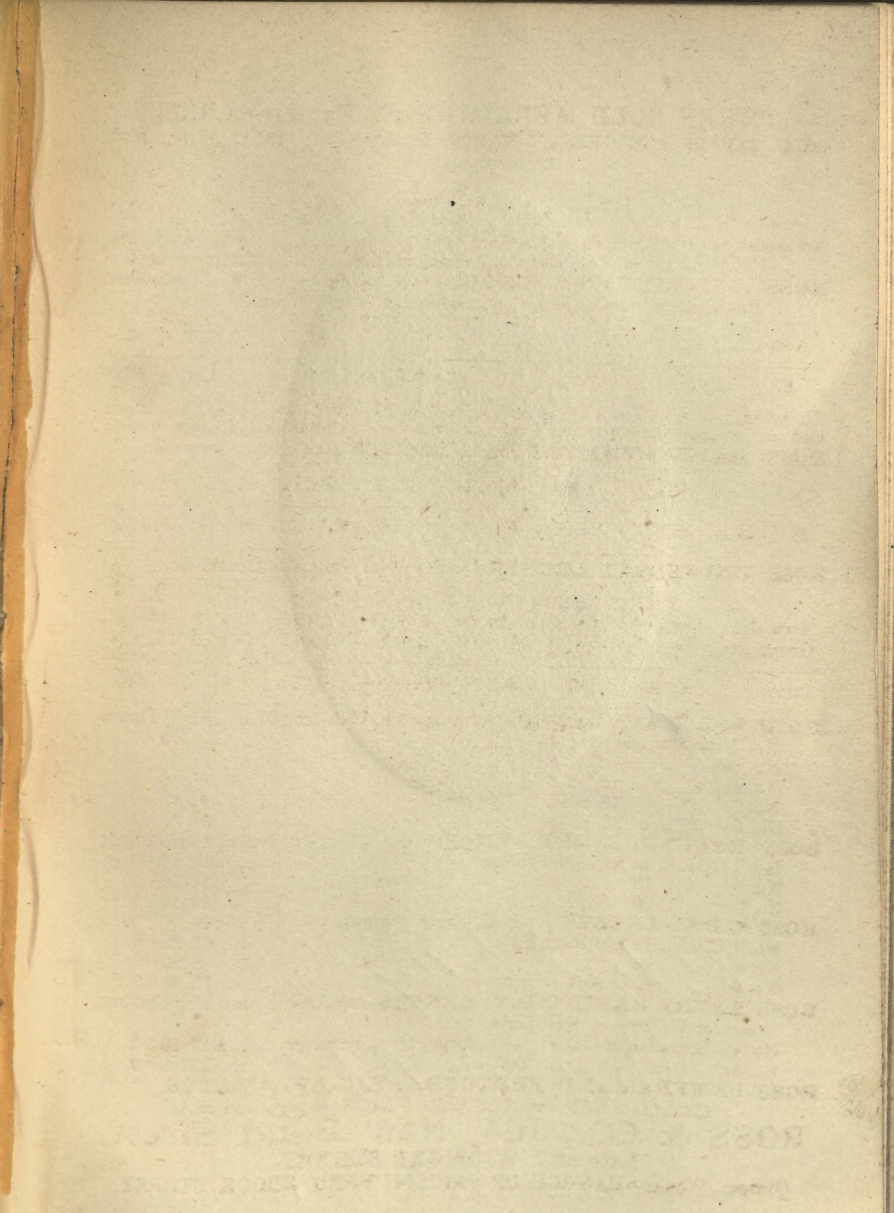
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IN
PHOTOGRAPHY.

BY
CAPTAIN ABNEY, R.E., F.R.S.,

*Late Instructor in Chemistry and Photography at the School of Military
Engineering, Chatham.*

FOURTH EDITION.

LONDON:
PIPER & CARTER, GOUGH SQUARE, FLEET STREET, E.C.

1879.

INSTRUCTION

PHOTOGRAPHY.

CAPTAIN ROBERT B. LEE

LONDON:

PIPER AND CARTER, PRINTERS, GOUGH SQUARE.

FOURTH EDITION.

PIPER AND CARTER, PRINTERS, GOUGH SQUARE, E.C.

PREFACE TO THE FOURTH EDITION.

A FEW remarks seem to be necessary in issuing another edition of this work, judging from the purport of several letters which have reached the writer since the last edition was published.

The writer has been frequently asked as to the easiest course to pursue in commencing practical photography. After an experience of seven or eight years in teaching many, who were totally ignorant of either photography or chemistry previous to coming to his hands, he has come to the conclusion that the best commencement to make is to master a dry-plate process. As to the dry-plate process to be adopted, the washed collodio-bromide process (such as given at page 84) is unhesitatingly recommended, beginning by making the collodion with purchased pyroxyline of the ordinary quality.

This having been learnt, the wet-plate process may be dealt with next, and then dry-plate processes with the bath. Whilst pursuing this course of study, silver printing may be practised with advantage; and when tolerably sure of the details, the carbon process may next be proceeded with.

This is a different order to that given in the work itself, since it was thought advisable to follow the course of tuition as usually adopted.

There is much that is new in the present edition, and it has been brought up to date in all essential practical details. Some part of the theory of photography has been revised in consonance with the writer's recent investigations, and it is believed that explanations are now offered of most of the phenomena met with in practical working.

It is hoped that the present one will be deemed to merit the same favourable reception which was accorded to the two preceding editions.

W. DE W. ABNEY,

Captain R.E.

Kensington, March 1879.

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INSTRUCTION IN PHOTOGRAPHY.

OBSERVATION has shown that nearly every metallic or organic compound undergoes change in the presence of ordinary light. The change may be visible to the eye, as in the case of the darkening of silver chloride; or, it may be invisible, and only to be ascertained by the behaviour of the compound when certain chemical agents are brought in contact with it; as an example we may take the case of a short exposure of iodide of silver in the wet collodion process. The latter change, however, is as real as the former, and any difference between them is, as a rule, solely in the *number* of molecules composing the compound which are altered.

When a thin slice of light is decomposed by a prism, it is separated into all the rainbow colours, which, though passing imperceptibly from one into the other, yet, for the sake of perspicuity, have been divided into seven primary colours. These are red, orange, yellow, green, blue, indigo, and violet. Experiment has shown that those colours which are included between the green and the violet cause a change in those silver compounds which are mostly employed by photographers, and that of these, that which produces the most rapid change is situated about half-way between the two. Those coloured rays of light which will effect a change (visible or invisible) are termed actinic, or chemical rays; all others, non-actinic.

It must also be noted that when a ray of white light is decomposed by a prism into its primary colours, that a change in a compound is often produced beyond the place where the extreme violet ray is seen. These rays, together with others below the red, are called dark rays of the spectrum, and are usually denoted as ultra-violet and ultra-red. As the former produce a change in the salt, they are likewise actinic rays.

It must be remembered, that white light only causes a chemical change in a compound, because, of its components, some are actinic; and it is because the red and orange rays are non-actinic that coloured glass of these hues is used in our developing rooms, the light admitted through such glass, if it be of good quality, being incapable of producing any *primary* change on the silver salt ordinarily employed.

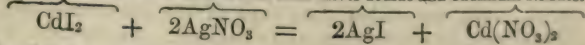
There are certain organic, silver, and iron compounds which are acted upon by the yellow and red rays, and even by dark rays in the spectrum below them, and when employing such it is necessary to be careful as to the light admitted, whilst developing an image impressed on them.

The invisible change which takes place in a compound exposed to a lenticular image, and to which we have already alluded as capable of being rendered demonstrable by the application of certain chemical means, is usually called the "latent," or, what is far preferable, the "photographic" image, and these terms are more particularly applied to the invisible change which takes place in a film containing or formed by a compound of silver; and such compounds as are capable of receiving an image are termed "sensitive salts."

The sensitive salts of silver which are usually employed in photography are, the iodide, the bromide, and the chloride of silver. There are others, which are rarely used, and to which we may refer further on.

In order to illustrate the theory of the formation of a photographic image, the iodide will be taken as a type, the action of light on the other salts being similar. Silver iodide (Ag I) can be formed in two or more ways—by the action of a soluble iodide on a soluble salt of silver, or of iodine vapour upon metallic silver. This first method is that employed for its formation in ordinary photography:—The soluble iodide of a metal, or alkali, such as cadmium, ammonium, &c., is brought in contact with a solution of silver nitrate; the iodine, having a strong affinity for the silver, forms silver iodide, setting the nitric anhydride free, which in its turn combines with the metal originally in combination with the iodine. Chemically, it is expressed thus—

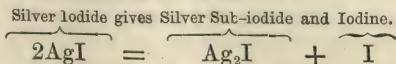
Cadmium Iodide and Silver Nitrate form Silver Iodide and Cadmium Nitrate.



In the above equation, if we were to substitute bromine (Br)

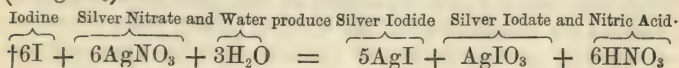
for iodine (I) the same would hold good, the decomposition being similar.

The chemical change that takes place in the iodide of silver by the light we have very good reason to believe to be the formation of a silver sub-iodide. Thus—



If no body which will absorb iodine* be present, this change will not take place, for if we thoroughly wash silver iodide, and treat it after exposure to light, with such a developer as will be presently indicated, no alteration in it will be manifest. It will, therefore, be evident that in wet plate photography the silver nitrate, which will be seen further on is left on the film containing the silver iodide, plays an important part.

Multiplying the above equation by 6, we have six atoms of iodine (6I) coming in contact with six atoms of silver nitrate (6 AgNO₃).



It must not be supposed that this chemical change necessarily takes place in the whole of the silver iodide present. Far from it—the change may take place in an infinitely small proportion of it, perhaps only on the surface of the minute granules exposed to light.

In dry-plate photography, the action of light is precisely the same; but the free silver nitrate solution is replaced by some body *which will combine with iodine.*

WET-PLATE PHOTOGRAPHY.

HAVING thus briefly treated of the action of light on a typical silver compound, it is now proposed to describe in detail the process commonly known as the collodion wet process. The sensitive salts of silver, usually employed in this process are

* This is not the case with silver bromide and chloride. A change is effected in these bodies without the presence of an absorbent.

† When bromine and chlorine are liberated from silver bromide and chloride respectively in the presence of silver nitrate, the reaction that takes place may be somewhat different, but not essentially so. In the above equation it is possible that oxygen is liberated, and no iodate formed.

the iodide and bromo-iodide, the former being used only for special classes of work, to which attention will be drawn. The following is an outline of the process:—1st. Collodion is prepared in which are dissolved bromides and iodides. 2nd. A clean glass plate is coated with a thin film of this prepared collodion. 3rd. When set, the plate is immersed in a solution of silver nitrate (usually called the bath solution), which causes the formation of silver iodide or bromo-iodide. 4th. The plate is then exposed in the camera. 5th. A developing solution is applied to bring out the image. 6th. The image is intensified or strengthened. 7th. It is fixed. And 8th a coating of varnish is given to the dried film to protect the delicate collodion surface. In this stage the negative is complete for printing purposes.

THE GLASS PLATE.

A few remarks are necessary on the glass that should be selected for camera work. As a rule, patent plate is recommended by most authorities on the subject, as being perfectly flat and of a good polish. It must, however, be borne in mind that patent plate is really nothing more than sheet glass which has been ground to a flat surface and then polished. The outer skin of all glass is always the hardest and most compact portion, and since the patent plate is denuded of much of the original surface, the inner portions of the sheet glass are consequently exposed to the action of the chemicals employed. In practice it is found that this glass absorbs impurities, during the photographic operations, which cannot be eliminated; and it is almost useless to expect to use the same plate above three or four times, a serious consideration to the tyro in the art when the high price of the article is remembered.

Sheet glass is generally "true" in one direction, but slightly curved in the other, but its surface is hard and well adapted for small-sized plates, where the curvature may be neglected. A good specimen of this glass is one to be recommended.

Crown glass, from the nature of its manufacture, has generally double curvature, and is to be employed for large plates with great caution, owing to its liability to snap in the printing-frame, and to throw portions of the picture out of contact.

Flatted crown is not open to this objection, but if it be really flatted its cost should be nearly that of patent plate. It

has a hard surface, and when a true sample of it is to be obtained there is nothing better that can be used.

For large plates, say over 15in. by 12in., patent plate is recommended; for the inferior sizes, flatted crown; or, failing this, the best sheet glass.

Flatted crown has only one surface that is smooth, the process of flattening (which consists in heating the ordinary crown to a red heat and allowing it to flatten on a plain surface) making the other slightly irregular.

CLEANING THE GLASS PLATE.

In order to make a plate chemically clean, some body must be found which will free it from mechanical dirt—such as dust—and also from grease. Alcohol has the property of holding most kinds of the latter in solution, hence it generally forms a portion of a plate-cleaning formula. Any alkali will turn grease into soap, rendering it soluble in water; hence this is often recommended as an addition. To free a plate from mechanical dirt, insoluble powder of an impalpable description is found to answer well when made up in a paste, hence the employment of tripoli powder and rouge. Common whitening has the property of absorbing grease when dry; hence a cream of this made up with water is sometimes applied to a plate, allowed to dry, and rubbed off in that state. The usual formula for a plate-cleaning solution is tripoli powder; spirits of wine sufficient to form a thin cream; liquor ammonia, about ten drops to each ounce of the cream. Rouge may be substituted for the tripoli powder, but unless it be of the finest nature, it is liable to cause scratches. It has also the disadvantage of injuring the bath if any be carried into it by the plate.

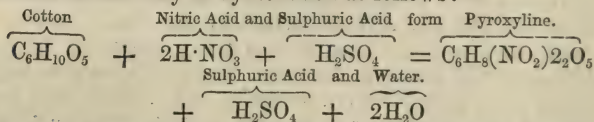
Plates carrying old varnished negatives, which are to be used again, should be allowed to soak in soda and water (one ounce of washing soda to two pints of water). This will generally secure the film leaving the plate. Should the films be unvarnished, hot water may be employed to remove the collodion. In both cases the plates must be treated with the cleaning solution.

It may happen that plates are slightly scratched, and refuse to become clean by ordinary means. Resort may then be had to albumen, &c., as given for dry plates.

COLLODION.

Collodion is a viscous fluid made by dissolving gun-cotton (*i.e.*, pyroxyline) in a mixture, varying in proportions, of alcohol and sulphuric ether, and is employed in photography as a vehicle in which the sensitive salts of silver are held for the purposes of exposure in the camera, &c. Its qualities vary with the kind of gun-cotton and with the proportions of the solvents used.

Pyroxyline is cotton or fibre (cellulose or lignine) which has been altered in chemical composition by treatment with a mixture of nitric and sulphuric acids, or an equivalent of the former. The change that takes place is due to the combination of nitrogen tetroxide with the cellulose or lignine. The chemical action may be symbolized as follows:—



It will be noticed that the sulphuric acid remains unchanged. Its use is principally dependent on its affinity for water. Hydrogen from the cotton is abstracted, and combines with the oxygen liberated from the nitric acid. This forms the water which the sulphuric acid absorbs. The formula shows that two equivalents of hydrogen are displaced by two equivalents of nitric peroxide. When three equivalents are displaced we have the true explosive gun-cotton. The difference in the temperature of the acids, &c., determines whether tri-nitro or di-nitro (pyroxyline) cellulose are formed.

The manufacture of pyroxyline is one of considerable difficulty, though not at all out of the range of ordinary skill. For amateurs the second process will, it is believed, be the most useful. The general directions given are those found in Hardwich's Photographic Chemistry. A method of preparing pyroxyline suitable for some kinds of dry-plate processes is given at page 58.

1st Process.—Sulphuric acid 1·845 at 60° F. 18 fluid ounces.*

Nitric acid 1·457	...	...	6	„
Water ...	...	...	4 $\frac{3}{4}$	„

* It need scarcely be said that great care must be taken to prevent the acid coming in contact with the skin or dress. An india-rubber apron and pair of gloves are useful to save the one and the other from hurt.

Or,	* Sulphuric acid (1.845)	...	18 fluid ounces.
	Nitric acid (1.45)	...	6½ „
	Water ...	...	4¼ „

The water is first poured into a strongly glazed porcelain basin, the nitric acid *next* added, and, *lastly*, the sulphuric acid. The mixture is well stirred with a glass rod. The temperature will now be found to be somewhere about 190°. It must be allowed to cool to 150°, and this temperature must be maintained on a water-bath. A dozen balls of cotton wool, weighing about thirty grains, should now be immersed separately in the fluid with the aid of a glass spatula. The cotton wool ordinarily obtained in commerce is contaminated with resinous matter of a varying character. In order to eliminate this source of uncertainty, the cotton is well boiled in an alkaline carbonate (such as sodium carbonate), then *thoroughly* washed, and finally carefully dried. In this state, if dropt into water, it will rapidly sink, whilst cotton wool in its ordinary condition will float on the surface for an almost unlimited time. Each ball of cotton should be pressed separately against the side of the basin till it is evident that the acids have soaked into the fibre. Care must be taken that each one is immersed at once. Failing this, a different chemical combination takes place, and nitrous fumes are given off, and the success of the operation will be vitiated. Immersing the dozen balls will take about two minutes. The basin should after this be covered up for about ten minutes.* At the expiration of this time the whole of the cotton should be taken up between two glass spatulas, and as much of the acids as possible should be squeezed out against the sides of a clean porcelain capsule. The cotton should then be dashed into a large quantity of water, and washed in running or frequent changes of water for twenty-four hours. Finally, when it shows no acid reaction to blue litmus paper, it is dried in the sun or on a water-bath.

2nd Process.—Sulphuric acid of commerce	6 fluid ounces
Dried potassium nitrate ...	3½ ounces (Av.)
Water ...	1 fluid ounce
Best cotton wool ...	60 grains

* The nitric acid of the strength given in this formula is cheaper than that of the first, and is of the standard strength; hence it is recommended for economy's sake to use it.

† This prevents the access of the air to the fluid, and consequent absorption of oxygen. A neglect of this precaution will increase the chance of nitrous fumes being evolved.

Mix the acid and water in a porcelain vessel, then add the nitrate (which has previously been dried on a metal plate to about 250°, and then pulverized) by degrees, stirring with a glass rod until all lumps disappear, and a transparent viscous fluid is obtained. This will occupy several minutes.

The whole of the cotton wool must now be separated into balls the size of a walnut, and immersed as stated in the first process, care being taken that the temperature is kept up to 150°. The cotton is then left ten minutes, and washed as before. Mr. Hardwich states that the chances of failure in this process "are very slight, if the sulphuric acid be sufficiently strong, and the sample of nitrate not too much contaminated with potassium chloride." If failure occur through the cotton dissolving in either of the mixtures, a drachm less water must be used.

In both processes the operation may be conjectured to be successful if the cotton tear easily in the hand, and if the original lumps cannot be easily separated. Should nothing but fragments of the lumps be detected, it is probable (if the acids used have been of the strength given above) that the temperature has been allowed to fall. When dry, the pyroxyline, on pulling by the hand, should break up into little bits, and not resemble the original cotton in texture.

The weight of good pyroxyline should be greater than the original cotton by about 25 per cent.

If the acids employed be too strong, the pyroxyline will have a heavier percentage of gain, and on solution yield a thick glutinous collodion; whereas, if the acids have been too diluted, it will probably weigh less than the original cotton, and yield a collodion adhering firmly to the plate, but giving negatives of an abnormal softness; with this specimen any small particles of dust that may fall on the glass will form transparent marks. The formula given above steers between the two extremes.

The following are formulæ which experience has shown are good for plain collodion:—

No. 1.—Pyroxyline	...	...	...	55 to 65 grains
Alcohol .820	...	...	...	4½ ounces
Ether .725	...	...	...	5½ "
No. 2.—Pyroxyline	...	...	...	55 to 65 grains
Alcohol .820	...	...	...	5 ounces
Ether .725	...	...	...	5 "

No. 1 is most suitable for winter; No 2 for summer work. The more alcohol in proportion to the ether that is used the slower will the collodion set. A limit, however, to the proportions that can be used arises from the fact that if the alcohol be added in excess, the film which contains the sensitive salts of silver becomes streaky and slow in securing the impressions of the photographic image; whilst if there be an excess of ether, the film becomes too contractile, and has a tendency to split on drying. In mixing the collodion the alcohol should be added first to the pyroxyline, as by so doing its dissolution is aided. It must also be remembered that the quantity of pyroxyline given above is dependent on its quality, whether it tend to form a gelatinous or limpid collodion. In the former case, less must be used; whilst in the latter, more may be added.

When plain collodion has been prepared, and a copious addition of water made to it, it is found that a portion of the pyroxyline remains in solution in the water, the precipitated portion being of a finer quality than the original. If this be dried and made up into collodion once more, it yields a beautifully textureless film. Should this method of "refining" the pyroxyline be determined upon, cheaper solvents, and half the quantities given, may be employed in the first instance.

Dr. Liesegang introduced a form of pyroxyline called papyroxyline. It is prepared from paper instead of cotton, and its value for giving tough films is great. Four grains of papyroxyline are equivalent to five of pyroxyline. A judicious mixture of the two in the solvents gives highly satisfactory results.

Iodides and bromides of metals or alkalies are added to the plain collodion, and when a film of this bromo-iodide collodion is formed on a plate and then immersed in a solution of silver nitrate, a fine layer of silver iodide and bromide is formed. If iodides are used alone, the developed image is usually dense, with but little detail in the high lights, and a long exposure is necessary in the camera. Bromides used alone give a fainter image, but full of detail, and the time required to impress a latent image on the sensitised film is shorter than when iodides alone are employed. It is thus evident that a judicious mixture of the two will give a film which, when sensitized, gives a mean between the delicacy of the bromide and the density of the iodide, whilst the time of exposure will be somewhat between that required for the two separately.

There is no doubt that the effect of different metals in com-

bination with the halogen has some effect on the qualities of the collodion. Thus, ferrous bromide has a tendency to cause the pyroxyline to revert to its original state of cotton. It is therefore evident that in choosing iodizers this must be taken into account.

The iodides and bromides of zinc, potassium, ammonium, and cadmium have all been tried by various makers. The two last are the staple iodizers and bromizers employed.

The following list may be useful in showing the amounts iodine or bromine in the iodides and bromides of certain of the metals, &c. Of others, the amounts can be calculated from the table in the Appendix:—

In 10 grains of potassium iodide there are 7·6455 grains of iodine								
"	"	"	bromide	"	6·7164	"	bromine	
"	"	"	cadmium iodide	"	6·9398	"	iodine	
"	"	"	"	bromide	"	5·8823	"	bromine
"	"	"	ammonium iodide	"	8·7586	"	iodine	
"	"	"	"	bromide	"	8·1632	"	bromine
"	"	"	magnesium iodide	"	9·1366	"	iodine	
"	"	"	"	bromide	"	8·6945	"	bromine
"	"	"	zinc iodide	"	7·9608	"	iodine	
"	"	"	"	bromide	"	7·1092	"	bromine

A standard iodizing solution having been arrived at by experiment with any of the iodizers and bromizers given above, the value of the others may be determined.

The following is a standard that has been found to answer well:—

No. 1.—*Cadmium iodide	...	...	4½ grains
Cadmium bromide	...	...	2 "
Plain collodion	...	...	1 ounce

On referring to the table the following modifications arise in the formula where alkaline salts are used:—

No. 2.—Ammonium iodide	...	...	3½ grains
Cadmium bromide	...	...	2 "
Plain collodion	...	...	1 ounce

* Cadmium renders collodion glutinous on first iodizing. When kept, it becomes more limpid. Ammonium fits collodion for more immediate use, as it does not cause it to become glutinous, even on first iodizing.

No. 3.—Cadmium iodide	...	...	2 $\frac{1}{4}$ grains]
Ammonium iodide	...	...	1 $\frac{2}{3}$ „
Cadmium bromide	...	...	2 „
Plain collodion	...	...	1 ounce
No. 4.—Ammonium iodide	...	...	3 grains
Cadmium iodide ...	...	...	$\frac{1}{2}$ grain
Ammonium bromide	...	...	1 $\frac{2}{3}$ grains
Plain collodion	...	...	1 ounce
No. 5.—Ammonium iodide	...	...	4 grains
Cadmium bromide	...	...	1 $\frac{1}{4}$ „
Plain collodion ...	...	...	1 ounce

No. 1 should be mixed at least six months before use; it then gives a delicate image and fine detail.

No. 2 should be mixed two months before use, and answers well for landscapes.

No. 3. should be prepared four months before use, and is good for portraiture.

No. 4 may be used after mixing two or three days, and is a good “general purpose” collodion.

No. 5 is a collodion much to be recommended. It gives fair density with detail, both in the high lights and shadows; it can be used two or three days after making.

The following general rules may be given for modifying the tendencies of collodion:—

1. If a *decrease* of contrast and more detail be required, add bromide.

2. If violent contrasts are wanted, the iodides should be increased and the bromides diminished. One quarter-grain of bromide to the ounce of collodion is found to be sufficient to secure cleanness in the shadows, and all but this quantity may be left out if necessary.

As before stated, for certain classes of work it may be necessary to resort to simply iodized collodion, no bromide being admissible. The following are formulæ which have been adopted:—

No. 6.—Ammonium iodide	...	...	4 grains
Plain collodion ...	...	...	1 ounce
No. 7.—Cadmium iodide	..	...	5 grains
Plain collodion ...	...	...	1 ounce

No. 6 should be iodized almost immediately before use.

No. 7 requires keeping, and is a most stable collodion.

It should here be noted that it is customary, though not necessary, to leave out half the alcohol from the plain collodion, and dissolve the iodide or bromide in the quantity thus omitted. This procedure has advantages, and may be followed if considered convenient.

Collodion should be stored in a dry and cool place to prevent the ether decomposing, which, in its turn, decomposes the pyroxyline. Collodion made with pure spirit and neutral cotton will be colourless after iodizing, but if made with impure solvents it will become first dark, but may afterwards return to its colourless condition. Should the pyroxyline be acid (not sufficiently washed after preparation), the collodion will become sherry-coloured almost immediately, but will not keep in good working condition for long.

Methylated alcohol and ether are often employed by manufacturers as solvents. Experience teaches that, although apparently harmless at first, they both, particularly the former, contaminate the silver nitrate bath if used for any length of time. It is also noticeable that a collodion made with pure solvents frequently refuses to work in a bath to which methylated solvents have had access.

Collodion should be always labelled and dated after manufacture and iodizing. This precaution will be found of the greatest use in selecting a specimen suitable for any particular purpose. The following is a specimen of a label:—

PLAIN COLLODION MADE 15th JULY, 1878.

Pyroxyline (prepared 1st June, 1870)...	6	grains
Papyroxyline	2	„
Sulphuric ether (pure)...	$\frac{1}{2}$	ounce
Alcohol .820	$\frac{1}{4}$	„

Iodized 4th August, 1878.

Ammonium iodide	$2\frac{1}{2}$	grains
Cadmium iodide	2	„
Cadmium bromide	2	„
Alcohol .820	$\frac{1}{4}$	ounce

Any bottle of collodion thus labelled will tell its own tale, and be a guide for future manufacture. With the collodion of commerce, all you can do in labelling is to give its date of iodizing; even this will be found very useful.

When the iodized collodion is of a pale straw colour, it is in its most sensitive condition, and this may be produced by adding a few drops of tincture of iodine. A certain amount of free iodine is almost a necessity to obtain bright pictures, for reasons which will be evident when the theory* of emulsions is studied; with methylated solvents more particularly, the colour may disappear after a time, and then more iodine must be added. After the iodized collodion spontaneously assumes the dark brown sherry colour, from the liberation of iodine,† it becomes less sensitive, and is more apt to give harsh pictures.

After plain collodion has been made, it should be allowed to stand till it is perfectly bright through the deposition of a fine sediment, when the top should be decanted or syphoned off. It should be tested before iodizing. A plate should be coated, and it should be observed if it dry with any opalescence. Next, the film should be tested to see if it be powdery, or if it come away in strips to the touch of the finger. After it is iodized, it should be tried by taking two or three negatives, the behaviour of the films being carefully noted. It is useful to have a sample of good standard collodion at hand with which to compare it. If the two halves of a stereoscopic plate be coated with the two collodions respectively, and the sensitized films be exposed simultaneously, their relative sensitiveness and densities may be readily determined, and the results should be noted for future guidance. Any defect in the collodion should, of course, be corrected.

Collodion which yields a thick creamy film gives a "plucky" image, whilst a limpid collodion give one thin and transparent. This latter can be improved by adding a grain or two of pyroxyline to each fluid ounce. Should this defect arise from the use of alcohol which is too anhydrous, it may be rectified by the addition of a drop or two of water to each fluid ounce. Collodion that has been iodized a long time often has this defect.

It will be found advantageous at times to mix the collodions prepared by different formulæ; thus, a collodion yielding great intensity of image should be mixed for general purposes with one which is deficient in this quality. This remark applies

* See "Emulsion Processes in Photography," page 14 (Piper and Carter).

† The whole of iodine must be liberated before any bromine can be found in a free state.

not only to home-made, but also to commercially supplied, collodions.

When testing the plain collodion, should the film dry matt, the sample must be rejected, as the pyroxyline must be unsuitable.

Should the film, after sensitizing, appear like watered silk, then the collodion is too alcoholic, or else contains too much iodide and bromide. The probable cure for this is the addition of a drachm to the ounce of plain collodion prepared according to formula 1, page 8. Should the defect arise solely from the collodion being too alcoholic, it is probable that if the film be allowed to set more thoroughly before sensitizing, a cure will be effected. When collodion is under-iodized, the developed image will be poor and flat, though it is necessary to distinguish between this cause for the defect, and that due to impurities in the negative bath (see page 47).

If the film, on drying, show "crape markings," the plain collodion has been prepared with solvents of too great a specific gravity—*i.e.*, with too much water in their composition. To remedy this defect, an iodized collodion, formed of absolute ether and alcohol, should be added till the markings disappear.

Should the collodion, on setting, prove of a horny repellent nature, the defect may be cured by shaking it up with a small quantity of carbonate of soda, and decanting the supernatant liquid from the residue. A drop or two of water to the ounce will frequently answer the same purpose.

If collodion be made up with absolute alcohol and ether, and the above amount of iodides and bromides, it will be found that the plate has the appearance of being stained with opaque streaks, especially at the corner of the plate from which the collodion was poured off, where, consequently it was least set. To remedy this it is a good plan to add water to half the amount of collodion, till it appears, on the withdrawal of the plate from the bath, to have the appearance of crape, then to add the remaining half to that portion which was watered. On trying a plate, it will be found that the film has lost the streaks, and is more dense than before. The amount of water that can be added depends a good deal on the quality of the pyroxyline.

THE SENSITIZING BATH.

The strength of the sensitizing bath is of the utmost importance in photography, as is also the purity of its constituents.

The silver salt employed is invariably the silver nitrate, as it is the form most attainable in commerce, and can generally be procured free from impurity. Silver nitrate is readily soluble in its own weight of cold water, and in a still higher degree in hot water; but for the purpose to which it is to be put in the present instance, a far weaker solution is preferable. When iodides or bromides are used in the collodion, the utmost strength admissible is 50 grains of silver nitrate to each ounce of water. For ordinary use even this proportion is too large, since silver nitrate in solution will dissolve up a certain amount of silver iodide,* the quantity depending upon the strength of the silver solution, and on the temperature. If the solution were not, therefore, saturated with the silver iodide, on the immersion of a collodion film the silver iodide would be partially or wholly dissolved out, according to the time of immersion. Now, it is easier to saturate a dilute than a strong solution, and a variation in temperature causes a less marked difference with the former than with the latter. It is therefore evident that the less silver salt in solution the more likely it is that the solution will not show signs of under- or over-saturation of iodide.

The acidity or alkalinity of the bath is a condition to which it is necessary to give attention, the sensitiveness of the plate being dependent in a great measure on it. When simply iodized (with no bromide) collodion is used, the solution should be strictly neutral, or very slightly acid, whilst with a bromo-iodized collodion it should be decidedly more acid, unless there be a large amount of free iodine present in the collodion. By a reference to page 3 it will be seen that the presence of the iodine will cause the liberation of the nitric acid in the film itself, and this is almost more effective than the presence of the acid in the silver nitrate solution, since the action of the nitric acid† is more local.

The sensitiveness of the plate is dependent to a great extent on the purity of the water employed. Distilled water is naturally the most free from impurities, though even in it they are to be met with, unless great precautions are taken to eliminate them. When distilled water is not obtainable, water purified as given in the Appendix should be used, though if rain-water, *not*

* It will dissolve scarcely any silver chloride or bromide, hence it is unnecessary to saturate it with these salts.

† For the explanation of this see "Emulsion Processes in Photography," page 14.

obtained from the roofs of town houses (or from the roofs of country houses, unless they have been thoroughly washed previously by a heavy downfall of rain), can be procured, it may be substituted with tolerable safety.

The following formula may be used for an ordinary negative bath when bromo-iodized collodion is used:—

Recrystallized silver nitrate	...	...	40 grains
Distilled water	...	...	1 ounce
Potassium iodide*	...	...	$\frac{1}{8}$ grain

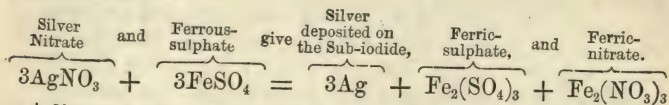
Take a quarter of the quantity of water that is to be used, and dissolve the silver nitrate in it; then add the potassium iodide, or other soluble iodide. It will produce an emulsion of silver iodide, which will be partially re-dissolved on agitation. Next add the remaining quantity of water, which will cause a re-emulsification of silver iodide. After filtration the bath solution should be tested for acidity or alkalinity. Blue litmus paper should redden slightly after a minute's immersion. Should the red colour be produced immediately, a little sodium carbonate should be added till a slight precipitate is produced. This should be filtered out, and the bath acidified with a few drops of a solution of nitric acid (1 drop of nitric acid to 12 drops of water). Acetic acid is sometimes recommended for acidifying the bath. If it be used, silver acetate is after a time formed, which is injurious to sensitiveness and cleanliness of work, and cannot be eliminated by any convenient method. Should the test-paper refuse to redden, the nitric acid solution should be added. As a rule, if recrystallized silver nitrate be used the bath will require the addition of neither alkali nor acid.

Before taking a bath solution (or *bath*, as it will be hereafter called, for brevity) into general use it should be tested. This is best done by immersing in it a plate coated with collodion. When fully sensitized the plate should be placed in the dark slide, *half* of it exposed to white light. It should then be developed. A trace of fog on the part to which the light had no access will denote that a slight addition of nitric acid is required, or that some impurity is present in the bath. The latter case will be considered when treating of the defects in negatives.

* Some prefer not to add any iodide to the bath, but allow it to become saturated by work. If a plate be moved about continuously in a bath made minus the iodide, there need be no fear of pinholes. It should be stated that with a solution of greater strength than that given it is very difficult to avoid them even when adopting this method of procedure.

DEVELOPMENT.

As already pointed out, the reduction of the iodide or bromide to the state of sub-iodide or sub-bromide may be invisible or latent. What is technically called a "developer" is that agent which brings the chemical change to the cognizance of our senses. Pyrogallic acid is a body which is well known for its affinity for oxygen, as are the ferrous salts, the latter being changed to the ferric state, that is, they combine with more oxygen. When the oxidation of these bodies takes place in the presence of silver nitrate the metal is deposited. We will take the example of the iron salts when applied to the latent image to see how development is effected. The theory is based on the assumption that silver sub-iodide or sub-bromide has an attraction for freshly-precipitated metallic silver, and which is consequently deposited upon those parts acted upon by light. The reaction that takes place is thus:—



A little consideration will show that if this action take place the image must be principally *on the surface of the film*, and not in it. Experience shows that such is the case.

In the formulæ for developers it will be noticed that the addition of (acetic) acid is invariably included. If to a solution of pure ferrous sulphate (or pyrogallic acid) a solution of silver nitrate be added, there will be an almost instantaneous deposit of metallic silver. If, therefore, such a solution were flowed over an exposed plate which had free nitrate of silver on it, an immediate precipitation of silver would take place all over the film. The attraction of the sub-iodide of silver would be rendered void, owing to the rapidity of deposition. With an acidified solution, however, the deposition would take place with greater regularity and less rapidity, and when sufficiently slow the sub-iodide would be able to attract all the particles of metallic silver as they were formed, and thus build up a metallic image. In practice the acid added is just sufficient to regulate this reduction of the silver. Since heat increases the rapidity of chemical action, it follows that in decidedly hot weather a larger quantity of acetic acid should be used than in cold.

It will also be noticed on the next page that different quanti-

ties of the ferrous salt for the developing solutions appear in the formulæ. The stronger the iron solution the greater chemical power it will have, and the more rapidly it will decompose the silver solution. Consequently, with a strong solution, all parts of the picture acted upon by light will immediately become nuclei for the deposition of silver, and the deposit will be of more even density than if a weaker solution had been employed; for with the latter those parts most acted upon by the light—*i.e.*, which had been most thoroughly converted into sub-iodide—having the most attractive force, would draw the deposit of silver to them, and the image would be much more intense at those parts than where the light had less strongly acted.

Acid developers may be divided into two great sub-divisions: iron and pyrogallic acid.

Pyrogallic acid developers are now rarely used, since it was discovered that ferrous sulphate was the better reducing agent. When iodized collodion is employed without a bromide in solution, pyrogallic acid may still be utilized. It gives a very dense image, and is found useful for copying purposes, though a much longer exposure of the sensitive film to the action of light is required than is necessary if the ferrous sulphate be used.

A good formula for a pyrogallic acid developer for negatives and positives is as follows:—

Pyrogallic acid	...	...	...	1 grain
Glacial acetic acid	...	...	...	20 minims
Alcohol	...	...	...	<i>quant. suf.</i>
Water	...	...	...	1 ounce

Since iron developers have been introduced there have been many modifications in the formulæ used. The following ten formulæ are applicable to the production of negatives, and will be found of the greatest utility:—

No. 1.—Ferrous sulphate					10 grains
Glacial acetic acid					15 to 20 mns.
Alcohol					<i>quant. suf.</i>
Water					1 ounce
No. 2.—Ferrous sulphate					30 grains
Glacial acetic acid					20 minims
Alcohol					<i>quant. suf.</i>
Water					1 ounce

No. 3.—Ferrous sulphate ...	...	...	50 grains
Glacial acetic acid ...	...	...	20 minims
Alcohol ...	...	...	<i>quant. suf.</i>
Water ...	...	...	1 ounce
No. 4.—Ferrous sulphate ...	...	...	20 grains
Copper sulphate ...	...	...	10 "
Glacial acetic acid ...	...	...	20 minims
Alcohol ...	...	...	<i>quant. suf.</i>
Water ...	...	...	1 ounce

The action of the different strengths of developers has already been pointed out, from which it will be gathered that in weakly lighted views without sunshine No. 1 would be used; in moderately bright light, No. 2; and in very bright light, or where the contrasts between the bright lights and shadows are very marked, No. 3 should be used to prevent an unnatural harshness of blacks and white; No. 4 is preferred by some photographers for landscape work. It gives clean and brilliant images, and the exposure is said to be shortened.

A good ordinary developer for general use, called "Wothly's Developer," is as follows:—

A perfectly saturated solution of the ferrous sulphate in water is prepared by adding six ounces of the iron salt to a pint of water.

No. 5.—Saturated solution of ferrous sulphate	2 ounces
Glacial acetic acid ...	$\frac{1}{4}$ ounce
Alcohol ...	1 "
Water... ...	16 ounces

This developer keeps well, though it, like other solutions, loses its power after long mixing.

The double sulphate of iron and ammonia has been employed as a developing agent with great success. It gives great delicacy to the image, and has the property of keeping an unlimited time in solution without change.

No. 6.—Ammonio-sulphate of iron ...	25 grains
Glacial acetic acid ...	25 minims
Water ...	1 ounce
Alcohol ...	<i>quant. suf.</i>

Formic acid is not a developing agent *per se*, but it seems to intensify the action of light on a sensitive film. Advantage has been taken of this property to add it to an iron developer.

No. 7.—Ferrous sulphate ...	...	...	30 grains
Glacial acetic acid ...	...	...	20 minims
Formic acid ...	...	...	10 „
Water ...	...	...	1 ounce
Alcohol ...	...	...	<i>quant. suf.</i>

The special qualities of this developer are, that short exposure is required, and detail in the shadows is brought out.

Another developer, as given by Rangel, is well worthy notice :—

No. 8.—Ferrous sulphate...	2 ounces
Water	10 „

Add to this, when dissolved,—

Ammonia ('880)	$1\frac{1}{2}$ to $1\frac{3}{4}$ drms.
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This will deposit the iron as protoxide. Add to the solution containing the precipitate—

Glacial acetic acid	2 ounces
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This will re-dissolve the iron protoxide. Two to three ounces of this to be added to one pint of water for ordinary use. It may be used of greater strength if requisite.

It will be found advantageous to dissolve the protosulphate of iron in the water previous to the addition of the acetic acid or alcohol. As a rule, a red deposit of iron will appear; this may be filtered out after the addition of the acetic acid.

This developer works very slowly, but very evenly, and is a very useful formula for beginners.

The addition of different organic substances to the developer has been proposed by various photographers. The following are most to be recommended :—

No. 9.—Ferrous sulphate ...	...	...	20 grains
Glacial acetic acid...	...	...	18 minims
Lump sugar ...	...	...	10 grains
Alcohol ...	...	...	<i>quant. suf.</i>
Water ...	...	...	1 ounce
No. 10.—Ferrous sulphate ...	...	...	20 grains
Glacial acetic acid ...	...	...	10 minims
Gelatine* ...	...	...	1 grain
Alcohol ...	...	...	<i>quant. suf.</i>
Water ...	...	...	1 ounce

* The gelatine should be first swelled up by cold water. Afterwards it should be dissolved by heat, and then the acetic acid added to it.

In connection with developers the colloidal restrainer introduced by Mr. Carey Lea should be noticed, since it has found favour with many photographers. It is prepared by taking one ounce of French glue, and softening in one and a-half ounce of water to which one drachm of sulphuric acid is added. The water is then boiled, to dissolve the gelatinous body, and, after the addition of half an ounce more of distilled water, the boiling is continued a couple of hours. Eighty grains of granulated zinc are next added, and the boiling again continued for one and a-half hour more. The solution is now allowed to settle, and the clear fluid is decanted off. To every three ounces of a fifteen-grain solution of iron one minim of this solution is added.

The addition of these "organifiers," as they popularly are termed, has an effect on the colour of the image, and the silver is deposited more slowly. The sugar is found not to necessitate a longer exposure than if the ordinary developer be used; but the addition of the gelatine requires the action of light to be more prolonged to yield equivalent detail. Great density in a negative is yielded by all these organifiers, but generally at the expense of the half-tones. They are not, as a rule, to be recommended, excepting for winter work, for copying plans, or for producing great contrasts in a landscape.

In all cases the ferrous sulphate will, after a certain time, absorb oxygen from the atmosphere, and become ferric sulphate. As ferric sulphate will absorb no more oxygen, it is evident that its developing powers are lost, and, in fact, it is found that it acts as a retarder. The change in the salt of iron is shown by a red, rusty colouration of the developer. This colour may become visible, in hot weather, two or three days after the solutions are mixed; in colder weather, a longer time elapses before the formation of any distinguishable ferric salt. A little ferric sulphate in the solution tends to keep the shadows in a negative bright, acting somewhat similarly to acetic acid.

In time the *crystals* of the protosulphate of iron slightly decompose, a yellowish powder forming on their faces. This is due to the formation of an insoluble oxide of iron. Allowance in weight should be made for this.

With a new bath containing little or no alcohol, developers may be employed without the addition of any alcohol. After the bath has been worked for some time it gets impregnated with the collodion solvents, and then the alcohol, *quant. suf.*, must be added to cause the developer to flow without repulsion.

And here it should be remarked, that pure spirits of wine should be employed, and not methylated. In the latter, resin is often dissolved, and which, if present, must inevitably ruin a negative, as the development is rendered uneven.

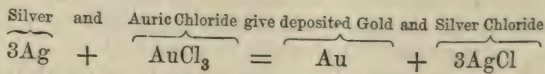
It may happen that the acetic acid procurable is weaker than the glacial quality.* If sufficient of the weaker kind have not been added, or if the weather be very warm, a scum will form on the surface of the iron solution during development. This indicates that more acetic acid must be added for the developer to work cleanly.

INTENSIFYING.

Any method of increasing the opacity of the developed image to the chemically active rays, either by changing its colour or rendering the deposit thicker, is technically called "intensifying a negative,"† and the agents used are called "intensifiers."

Either pyrogallic acid or ferrous sulphate may be employed with a solution of silver nitrate to increase the density by thickening the deposit of the metallic silver. The reactions here are analogous to those of development, except that the metallic silver is the attractive matter instead of the sub-iodide. As the silver is gradually reduced to the metallic state, it is deposited on the silver already reduced by the action of the developer.

There are other methods of increasing the deposit, such as treating the deposited silver with mercuric di-chloride, to form a double salt of mercury and silver, and a change may take place in the colour as well as in the density of the deposit. Change in colour may be produced by substitution; as an example, if we treat the developed image with gold tri-chloride, we shall have the following reaction:—



In other words, the gold displaces the silver. The equation, however, indicates that the image would be weakened in density, as one atom of gold takes the place of three of silver.

* A method of estimating the strength of the acetic acid is given in the Appendix.

† Manifestly, adding to the thickness of the deposit of a positive picture is useless. The colour may, however, be changed, in which case the action is termed "toning," and not "intensifying."

The following are formulæ for "density" intensifiers:—

No. 1.—Pyrogallie acid	...	...	...	2 grains
Citric acid	...	...	...	2 to 4 „
Water	...	...	...	1 ounce
No. 2.—Ferrous sulphate	...	...	...	5 grains
Citric acid	...	...	...	10 „
Water	...	...	...	1 ounce

No. 3.—An ordinary developer without alcohol.

Nos. 2 and 3 are usually employed in portraiture, and they are unusually efficacious in bringing out detail.

No. 1 brings up density more quickly than Nos. 2 and 3, and acts well for a properly exposed picture. Any of the above may be used either before or after fixing. To each a few drops of a ten-grain solution of silver nitrate should be added immediately before it is applied to the negative.

The next formula is for changing the metallic silver, after the image is fixed, to the state of iodide.

No. 4.—Iodine	...	...	...	1 grain
*Potassium iodide	...	...	...	2 grains
Water	...	...	...	1 ounce

After this solution has been applied to the film, any of the following may be used to cause the formation of a non-actinic colour.

Potassium permanganate intensifier (Mr. Wharton Simpson's).

No. 5.—Potassium permanganate	...	...	...	18 grains
Water	...	...	...	1 ounce

This is most easily applied by immersing the plate in a flat dish containing the solution till the image appears of a yellowish colour throughout. The potassium permanganate is decomposed on coming in contact with the silver iodide, and parts with its oxygen, which combines with the silver; at the same time the insoluble binoxide of manganese is precipitated on the image.

No. 6.—Uranic sulphate	...	...	...	1 drachm
Potassium ferri-cyanide	...	...	...	1 „
Gold ter-chloride	...	...	...	1 grain
Water	...	...	...	20 ounces

* Iodine is very sparingly soluble in water; if potassium iodide be added, complete solution takes place.

The colour of the deposit by this intensifier is changed to a rich chocolate brown. The solution should be used in a flat dish.

No. 7.—*Mercuric di-chloride	...	...	2 grains
Water	...	...	18 ounces

Add a solution (10 grains to 1 ounce of water) of potassium iodide till the red precipitate formed by its addition is on the point of becoming permanent.

No. 8.—†Mercuric di-chloride (corrosive sub- limate)	...	...	20 grains
Ammonium chloride	...	...	20 „
Water	...	...	1 ounce

With Nos. 7 and 8 the following solutions may be used, should sufficiently density (as would be the case in copying plans) not be obtained. The reactions that take place when employing them are manifest without explanation.

Ammonium sulphide	...	...	1 ounce
Water	...	...	30 ounces

Or,

Potassium cyanide...	...	...	5 grains
Water	...	...	1 ounce

Silver nitrate to be added till a permanent precipitate is obtained. This last solution should stand a night before it is used.

Or,

Ammonia	...	...	...	1 drachm
Water	...	...	...	1 ounce

Nos. 4, 5, 6, 7, and 8 must not be applied until the image has been fixed.

An intensifier which has met with much favour is made as follows:—

No. 9.—A 50-grain solution of copper sulphate 1 ounce

A 30-grain solution of potassium bro-
mide... .. 1 „

The mixture is flowed over the fixed image till it is perfectly

* In this case No. 4 formula need not be used, as the potassium iodide in this plays its part.

† Mercuric di-chloride is only sparingly soluble in water; the addition of ammonium chloride causes it to dissolve readily.

blanched. After thoroughly washing under a good stream of water, the image is flowed over with a 100-grain solution of silver nitrate, when an intense black will be produced. The first solution produces silver bromide and copper sub-bromide, the latter leaves the bromide unchanged; but the copper sub-bromide is converted into silver sub-bromide.

Eder and Toth intensify with the following solution:—

No. 10.—Plumbic nitrate	...	...	20 grains
Potassium ferricyanide	...	...	30 "
Water...	...	...	1 ounce

The plate is well washed, after fixing, with fairly pure water (free from sulphates), and is immersed till the image becomes opaque. It is again washed till the transparent parts are free from any deposit which may be on them, when it is treated with

Ammonium sulphide	...	...	1 part
Water	...	...	5 parts

When the sensitive film has been exposed, and developed sufficiently to bring out the details of the image, and when there is no tendency for the shadows to be "fogged" or veiled, intensification, *by increase of density*, should take place *before* fixing; if there has been over-exposure, *after* fixing. With an over-exposed picture, intensification before fixing acts as a development, and would cause fog; in most cases it is wise, before using the intensifier, after fixing, to flood the plate with No. 4.

FIXING.

After the development of the latent image or picture formed upon the sensitive collodion film, the silver iodide and bromide are left unaltered.

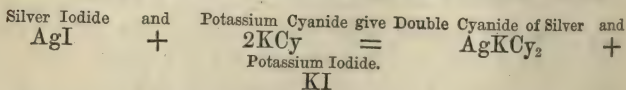
Looking at the reverse side of the plate (that which does not bear the film), the yellow colour of the iodide and bromide of silver will be apparent.

Were the unaltered iodide and bromide left in the film, a print taken from such a plate would be found to be *nearly* a blank, as these bodies possess almost as much power of preventing the passage of light as the reduced silver itself. There are certain chemical compounds which, in solution, are capable of dissolving them out of the film, leaving the metallic silver unchanged. These solvents are termed "*fixing agents*," and the operation of

dissolving out the silver iodide and bromide is termed "*fixing* the image." Dismissing the chlorides of the alkalis and potassium iodide (owing to their imperfections as fixing agents), the first solvent of iodide, bromide, or chloride of silver that is to be noticed is sodium hyposulphite ($\text{Na}_2\text{S}_2\text{O}_3$).*

The chemical reaction of this salt upon the bromide and iodide is similar to that upon the chloride (for details of the reaction see "Silver Printing").

The only other fixing agent that is in general use is potassium cyanide (KCy or K,CN). The following is its chemical reaction:—



Potassium cyanide† has also a slightly solvent power on finely-deposited metallic silver. If a test-tube be coated with a fine layer of metallic silver (see "Silvering Mirrors," in Appendix), it will be found that a strong solution of the cyanide will completely dissolve it after a short interval of time. From this simple experiment we learn the necessity of using a weak solution of this fixing agent, and allowing it to remain on the plate as short a time as possible, since the image is metallic silver in a very fine state of division, more particularly in the half-tones.

Most photographers recommend the hyposulphite, in preference to the cyanide, as a fixing agent, owing to the latter's poisonous character and liability to eat into the half-tones. The colour of the negative given by the latter, by reflected light, is whiter, but by transmitted light browner, and, consequently, more non-actinic than if the former be used. For this reason, and also on account of the slightly diminished washing that is required to free the film from the traces of the fixing solution, the cyanide is recommended as the agent to be generally employed. If ordinary precautions are taken, it need not prove hurtful to the operator through inhalation or otherwise; and if the film be

* More correctly called the thio-sulphate.

† The potassium cyanide is a *deadly* poison, and great caution should be exercised in working with it. Its fumes are deleterious to the system, and if the solution come in contact with a cut or sore place in the skin, festering is liable to occur. Should, by any accident, any of the solution be taken internally, a draught of iron developer taken immediately will render it innocuous.

washed *immediately* after the haloids of silver are dissolved out, there need be no fear of an attack on the half-tones. Sodium hyposulphite is to be avoided, on account of the mischief which even one drop of its solution causes to the bath.

Great care should be taken that no acid come in contact with the cyanide solution, as it is decomposed, and hydrocyanic acid vapour (prussic acid) is given off. The vapour is almost more dangerous than the liquid solution.

The following are the formulæ usually adopted:—

No. 1.—Sodium hyposulphite	...	...	1 ounce
Water	...	...	6 ounces
No. 2.—Potassium cyanide	...	...	25 grains
Water	...	...	1 ounce

VARNISHES.

Varnish is used to give protection to the delicate collodion film. It is simply a resin or resins dissolved in spirit of some description. When the solvent evaporates spontaneously, or by aid of heat, a thin layer of the resin is left, which gives the necessary toughness to the image to prevent damage in printing operations.

As a rule, it may be stated that the more colourless a varnish, the more suitable it is for negatives.

The solvent used for varnishes is usually methylated alcohol. Since undiluted methyl is a solvent of pyroxyline, it is important that the specific gravity of the solvent should be so great that the image may not be dissolved away with the film. It should also be noted that the resin dissolved in pure alcohol of low specific gravity will dissolve pyroxyline, hence varnish should not be made with absolute alcohol.

The proportions of the constituents of most photographic varnishes are, as a rule, trade secrets, but the following answer well:—

Alcohol	...	...	...	16 ounces
*Unbleached lac	...	...	...	2
Sandarac	...	...	...	2 "
Canada balsam	...	...	...	1 drachm
Oil of thyme or lavender	...	...	...	1 ounce

* Bleached lac absorbs moisture, and tends to make the varnish crack.

The resins should be dissolved in the alcohol by means of a water bath. The plate should be warmed as hereafter to be described, heat aiding hard and bright drying of the varnishes.

Seed lac	...	...	...	1 pound
Methylated spirit	...	...	...	1 gallon

The seed lac is allowed to remain in contact with the solvent two or three days, shaking at intervals to aid solution. The clear liquid is then decanted off, and thinned down (if necessary) to a proper fluidity.

Amber varnish, which is applied to a cold plate, is made as follows:—

No. 1.—Amber, in fine powder...	...	1 ounce
Chloroform	...	16 ounces

Or,

No. 2.—Amber ...	...	1 ounce
Benzole...	...	16 ounces

The amber should be heated in a closed vessel to a temperature of 570° Fah., when it will begin to soften. It can then be dissolved readily by the solvents.

In some cases but a few prints may be required from a negative. As a resinous-varnished film is difficult to wash off the glass, the following may be substituted for the spirituous varnish:—

Albumen	...	...	...	1 part
Water	...	...	...	3 parts

A dilute solution of gum-arabic may be used instead. In both cases the drying of the film should take place spontaneously. If the collodion film be dry, it should be wetted previous to the application of the albumen or gum solution.

MANIPULATIONS IN WET PLATE PHOTOGRAPHY.

CLEANING THE PLATE.

It is advisable to grind the edges of the plate previous to taking it into use. This may be effected by a corundum file supplied for the purpose by most dealers. An ordinary fine file will answer, but it is then a good precaution to moisten it with a

little turpentine, to prevent fine particles of glass* from flying on to the surface of the plate. Turpentine also gives a better bite to the file. Failing these implements, the edge of one plate may be drawn against the edge of another, which will partially accomplish what is desired.

The tip of the thumb-nail should now be passed over both surfaces of the plate to ascertain which was polished in the manufacture. The unpolished surface generally feels gritty to the touch. If both surfaces feel rough, the plate should be immersed in nitric acid and water, and allowed to soak for a few hours. It should then be washed under the tap, and allowed to drain. If there be many plates to drain, they should be kept separate from one another.† A good method is to stand them on edge on the floor or table, so as to support one another, as we see children make cards support one another in building a card house. When drained, the tripoli powder solution should be applied to the plates with a tuft of cotton-wool or old rag. A small quantity, sufficient to form a pool the size of a sixpence, may be poured on the plate, and rubbed well over the surface. It is sometimes recommended to let this dry, but, as a rule, it is preferable to remove it whilst moist, taking care that there is no arrest of motion before the surface appears bright. A diaper duster, which has been well washed in plain water and then dried, should be employed to rub off the cleaning solution.

A perfectly dry silk handkerchief or chamois leather should be reserved to give the final polish. (These should be well washed in sodium carbonate, or pearlash and water, then well rinsed, and finally dried, before use.) The motion of polishing the plate should be light, and in a circular direction. Polishing generates electricity, positive on the plate, and negative on the rubber, and electricity prevents the adhesion of the collodion film to the glass; but the electricity may be dissipated by passing the handkerchief or cloth *very* slowly over the surface. This allows the re-combination of the two electricities. Sometimes it is useful to have a plate-holder on which to clean plates. There are certain unscientific holders which the unthinking tyro purchases, with the result that in his endeavour to get a firm

* When subsequently cleaned they might cause scratches on the surface.

† If the water contain chalk or other soluble solid impurity, that when the edge of one is allowed to rest against the surface of another plate, an opaque chalky mark is formed on the latter, this will entail the application of acid once more.

hold of the plate with it, he breaks his glass, and throws up plate-holders altogether in disgust. The plate-holder recommended by Mr. Paget, however, may be relied upon. It is described as follows:—

“The cleaner consists of a board covered with two thicknesses of flannel, held down by strips of wood on all sides except at C (fig. 1), where there is a thumb-hole. The strips

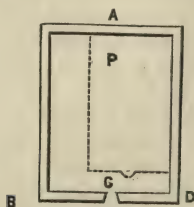


Fig. 1.



Fig. 2.

are of the same thickness as the glass, or are feathered down to that thickness at the inner edge, and enclose a space of the exact size of the glass, which is thus held firmly in its place. The strips are not under-cut. On the contrary side of the board from the flannel is fixed a strip of wood along the side B D, and a peg at P, both of which are shown in fig. 2, which is a section, through A C, of fig. 1. A hole is bored in the table at the distance P C from its edge, so that the cleaner is held perfectly fast by the strip and peg, without any assistance from the hand; and when a plate is placed in it, the glass is, for practical purposes, as firm as if it were glued to the table, but yet it may be removed by the thumb in a moment. When part of the table can be spared for the purpose, the flannel may be laid upon it and the strips screwed through the flannel to the table, thus forming a fixed plate-cleaner of the very simplest possible construction.”

Where different sizes of plates are used, L pieces, giving the proper dimensions, may be made as shown in the diagram.

If the polishing be complete, condensed breath should leave the plate in a regular and even manner. When breathing on a plate, the mouth should be kept near its edge, and almost on a level with the upper surface, and care should be taken that no small particles of saliva fall on it. The moisture from the breath should be fully dissipated before an attempt is made to

re-polish. If not, transparent patches on the plate will be visible when it is breathed on again. A golden rule to remember is, that *every plate has two surfaces to be cleaned*.

Clean plates can be well stored in absolute contact with one another, provided they are tightly packed. If loosely packed, any small particle of grit that may get between them will be liable to cause scratches on the surfaces. Another method of storage is in plate-boxes. This is not satisfactory, since all glass in contact with the air is liable to attract moisture and greasy matter. Clean blotting-paper is the best substance in which to pack clean plates.

COATING THE PLATES WITH COLLODION.

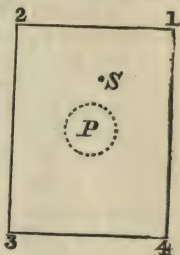
It is inadvisable to coat a plate with collodion from a bottle which can contain more than five or six ounces, and a bottle of this size should only be filled up to an inch or so below the neck. A large bottle is unwieldy, and the collodion is apt to run down the sides of a completely filled bottle. Convenient pouring bottles for the dark room have been introduced, but for out-door work the ordinary six-ounce bottles* will answer well. It is recommended that corks should replace glass stoppers: the former clean the inside of the neck of the bottle from the thick collodion, whilst the latter are apt either to stick fast, or to be forced out by the ether vapour when the weather is warm.

If practicable, the collodion from the plate should not be returned into the same bottle as that from which it was poured, as any floating dust which fell upon it whilst coating one plate would probably appear on the next. Owing to the evaporation of ether, collodion in time will become too thick for use, and must be thinned with a mixture of one part of alcohol to two parts of ether.

Dust should be removed from the plate with a broad badger-hair brush before coating. The brush must be perfectly dry, and care should be taken not to generate electricity by too vigorous a motion.

* A broad lip aids much in securing a uniform flow, and prevents the collodion running down the outside of the bottle.

In coating a plate, the use of a pneumatic plate-holder* is a great comfort; if it be used, it should occupy the centre of the plate, as shown in the figure by P. The plate should be held at first horizontally, corners 1 and 2 being away from the manipulator. The collodion should be poured on to a spot S, the mouth of the bottle being as nearly as possible in contact with the plate, in order to avoid the formation of air-bubbles. S is fixed by the fact that the wave of collodion should reach corner 1 when such a quantity is on the plate as is just sufficient (or barely more) to cover a circular patch of the width of the plate. The collodion wave should then be caused to flow to 2, next to 3, and finally the excess should be poured off at 4. The wave should be directed successively to these points by slightly tilting the plate. Whilst the collodion is being poured off at 4, the plate should be rather more tilted, till the excess has been drained off, after which it should be made to resume a nearly horizontal position, a slight inclination in the direction of 4, however, still being preserved. A gentle rocking motion should now be given to the plate, but there should be no grinding of the glass from the edges of the plate against the neck of the bottle, as small particles of glass might fall into the collodion, and appear as imperfections in subsequent films.



The collodion wave should not pass twice over the same spot, especially near corners 1 and 2. If it do, the almost invariable result is a thickening of the film at that place, which has the appearance of a drooping "curtain" by transmitted light. Should an air-bubble spoil the surface of the film, a second coating of collodion may be given: This will generally correct the fault.

Should no pneumatic plate-holder be at hand, the plate, if of moderate size, should be held by the thumb and middle of the first finger by corner 2, the extreme point of the corner alone being held by the cushion of the thumb. This manner of holding will enable the entire plate to be covered, and the disfiguring uncoated triangular portion at corner 2, so often seen, will be avoided.

* One holder should be religiously preserved for collodionizing the plate, and for no other purpose; another one should be set aside for the developing and fixing operations.

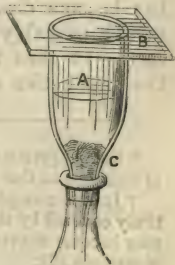
When the plate is of such dimensions as to cause the above method of holding the plate to be convenient, a valuable auxiliary is a bottle weighted with shot. A wooden ball covered with chamois leather has a rod inserted in it, the other end of which is fixed in the neck of the bottle. To coat a plate with its aid, one corner rests on the ball, and the opposite corner is held by the fingers, as before indicated.

When the collodion at 4 refuses to drop, and the film at 2 appears to the finger to be in a tacky state, the plate is ready for immersion in the bath. This "setting" of the film, as it is technically termed, is brought about by the partial evaporation of the ether and alcohol from the collodion.

In hot weather, two minutes will generally suffice to cause setting, whilst in cold weather five or six minutes, or more, will be necessary. It is important that the right moment should be seized for immersing the plate in the bath, since defects in the film may make their appearance on development, or during sensitizing, if the collodion be insufficiently or too much set.

It has of course been supposed that the manipulator has examined his collodion to ascertain if it be free from small particles of undissolved pyroxyline or dust, also that no incrustation is on the neck of the bottle. The former will give plates which are specky in appearance, whilst the latter will speedily tell its own tale.

Collodion should, if practicable, be decanted from a larger into the smaller pouring bottle, either by means of a syphon arrangement, as usually employed in the laboratory, or by carefully pouring off the top layer of the fluid. Collodion holders are to be obtained, holding from a quart upwards, which have a glass stopcock inserted about $1\frac{1}{2}$ inches from the bottom. With this arrangement the collodion can be drawn off free from sediment. It, however, frequently occurs that even decantation will not free the collodion from small floating particles. When this is the case resort must be had to filtration. A convenient filter is to be obtained from Messrs. Powell, of Whitefriars Glass Works. A is a funnel with ground top, to which a glass plate, B, acts as a cover. Prepared cotton wool or glass wool is packed tolerably firmly at C,



and is then moistened with alcohol (.820). The collodion is introduced into the funnel, and is allowed to filter through the plug into a bottle beneath.

SENSITISING THE PLATES.

The glass plate having been coated, the next operation is to sensitize the film by converting the soluble bromo-iodide into silver bromo-iodide. Most foreign photographers employ a horizontal tray to hold sensitising solution, but it is not recommended excepting for plates of very large size, in which case it is absolutely necessary to employ this form of apparatus. The usual form of holder used for holding the solution is the vertical dipping bath, into which the plate is lowered by a dipper.

The corner of the plate from which the collodion has been poured off should be allowed to remain downwards.* When placed on the dipper in this position the plate should be *gradually lowered, without stoppage*, into the dipping bath.

When once covered, the plate may be gently moved up and down (and also horizontally if the bath be large enough) till all repulsion of the aqueous for the alcoholic solution has disappeared. The effect of this repulsion is known by the bath solution collecting in tear drops and rivulets on the surface of the film, and is technically called "greasiness." This operation will probably take two to four minutes in cold, and only one and a-half in warm weather.

When this motion is not given to the plate in the bath, the alcohol often collects in permanent rivulets on the surface of the film, preventing the access of the sensitizing solution to the bromo-iodides beneath them. When, finally, the alcohol has become dissolved in the water, the beds of these rivulets would probably be less dense than those portions which had access at once to the bath solution, and the result would be the production of a streaky negative. By washing off the

* Some operators keep this corner upwards. This may cause a "curtain" of collodion at that part of the plate.

† In this manipulation great care should be taken that the plate is kept entirely covered by the bath solution during the first minute, otherwise the film may become unevenly sensitized at the upper end, presenting an appearance of watered silk.

alcohol, as described, no rivulets can collect; the film must become evenly sensitized, even before the total "greasiness" has disappeared.

When the greasiness can no longer be traced, the plate should be allowed to remain at rest for another minute and a half to three minutes, when, after a few more vertical motions in the bath, it may be taken out.

This last operation is generally performed in a hurried manner. Were more thought ordinarily exercised over every operation, many vexatious failures and much loss of time would often be avoided. A very little reflection must point out the utility of abstracting the plate *very* slowly. The capillary attraction of the liquid in the bath for the liquid on the plate will, if time be given, almost prevent the necessity of draining. The advantage of this force of nature is entirely lost by a rapid removal of the plate.

In taking the plate out of the bath-holder, the dipper holding the plate should be very slowly raised, till a corner of the glass can be seized by the fingers of the disengaged hand. The top edge of the plate should be forced away from the dipper (if it be not made of silver wire), in order to prevent an accumulation of bath solution between these two surfaces, and the plate is then raised till it is clear of the solution, when it is immediately turned to the position it is to occupy in the dark-slide.

It will be remarked that different lengths of time for sensitizing are given below, to understand the reason of which the nature of the sensitizer, the proportion of iodide to bromide in the collodion, the strength of the bath solution, and the temperature must be considered.

1st. With a strong bath solution a less time is required for fully sensitizing the film than with a weak one.

2nd. The greater the amount of bromide in the collodion the longer the operation will take, as the formation of silver bromide is much less rapid than that of the silver iodide.

3rd. The colder the weather the longer will be the time of immersion, as cold renders the access of the bath solution to the film more difficult.

A general rule as to the length of time required for sensitizing ordinary commercial collodion is to immerse the plate three minutes in summer and six in the winter.

Before work is commenced, the bath solution should be freed from any deposit that there may be at the bottom of the

bottle. Filtration* should not be resorted to more than is absolutely necessary. Decantation of the clear liquid from the sediment should first take place, and then the remainder (containing the deposit) may be filtered if required.

MANIPULATIONS AFTER SENSITIZING THE PLATE AND BEFORE DEVELOPMENT.

After the plate has been slowly withdrawn from the bath, it should be carefully drained on a pad of blotting-paper (three or four thicknesses at the least should be used), the end that is to be lowest in the dark slide being pressed down on to the pad; this prevents an accumulation of bath solution at the edge, and its consequent liability to cause stains.

The dark slide should be opened at the back, and held *nearly vertical*, and the plate put upon the silver wires (see Appendix) after the drainings from former plates have been removed by blotting-paper. This vertical position is one which in practice is often neglected, but is of great importance, since any silver solution which may have collected, notwithstanding proper draining of the plate, is thus prevented from running over the surface, and causing markings.

The back of the plate should then be carefully wiped with a pledget of blotting-paper or rag, to remove any silver nitrate solution which may have collected on the back. Should this precaution be neglected, horse-shoe markings (see "Defects in Negatives," page 49) on the developed image may be expected if the film be translucent.

Should the exposure be of considerable length, or if the time between placing the plate in the dark slide and development be likely to be long, a moistened sheet of blotting-paper should be placed at the back of the plate. This will keep the film moist through the evaporation of the water, and if the blotting-paper be red, in a measure, it will prevent halation or blurring of the image.

Finally, a strip of blotting-paper should be placed at the lower edge of the plate, and just in contact with the film, in order to

* When filtration is resorted to, the honey-combed side of the filter paper should be next the funnel, and it should be moistened with distilled water before the solution is run through. Some filter papers contain contamination which is injurious to the bath, and should be tested. See Appendix.

prevent any accumulation of the bath solution during exposure. The practice of letting the blotting-paper come between the film and the silver wires which hold the plate in position is to be condemned, since the inner surface of the silver wires is made to coincide accurately with the surface of the ground glass; hence, if the film do not touch the silver wires, the whole focus of the picture is altered.

The slide should then be closed, wrapped round with a cloth, and carried carefully in the same relative position as regards top as it will occupy in the camera during exposure.

The view should, of course, have been previously focussed on the ground glass of the camera. A few hints on the method of focussing may not be amiss.

The point of view having been chosen, and the camera placed approximately in position, the operator will endeavour to cause every object in the field of view to be sharply defined on the focussing-screen. He will guess which diaphragm (technically termed a stop) to use, and having inserted it in the lens, will proceed to get his final focus.

Should an architectural subject be the subject of the picture, it will be necessary that the perpendicular lines should be strictly parallel. As a rule, if it be a near view, the camera will have to be tilted in order to bring in the whole of the subject; but before doing so the front board of the camera which carries the lens should be raised to its full extent (*i.e.*, as far as the slot which secures the screw will allow). This will raise the image from the bottom of the ground glass, and reduce the tilt necessary to be given. When sufficiently tilted, the surface of the ground glass must be brought perpendicular to the horizontal plane—that is, it should be plumb. If it be at an angle to the perpendicular, vertical lines which should be parallel in the picture will converge. It may here be remarked that the ordinary single lens will always show as curves what in the view are straight lines, when they lie towards the margin of a plate; hence architectural subjects should, as a rule, be taken with a doublet, or any non-distorting lens. A spot about one-third way from the centre of the picture and the edge should be selected, and that brought into sharp focus. If the diaphragm used be small enough, this will generally secure an equable focus throughout the picture; other points should then be selected and tried for focus; and that point which makes the focus

generally sharpest should be selected as final. It should be noted that *the* object of interest should be especially sharp; a slight lack of definition in other portions being sometimes an improvement, as causing the eye to wander less from the spot on which it was intended to rest.

Should it be a landscape that is to be photographed, the swing-back need not be kept in a vertical position, as the perspective will not obviously suffer. In fact, it often happens that a large diaphragm may be employed, by judiciously using the swing-back to bring the foreground and distance into focus together, for the nearer the object the longer will be the focus, and *vice-versa*. Hence by pulling out the top of the swing-back the lengthening of the focus is obtained, instead of by the employment of a small diaphragm.

Care should be taken that the screws fixing the camera to the legs are tight, and that the latter have a firm grip on the ground. Where the ground is soft this is especially to be watched.

The object to be photographed having been properly focussed, the cap is replaced on the lens and the slide gently placed in the camera. The front of the slide is next pulled out, and the exposure commenced. (It is often advisable to place the focussing-cloth round the camera and over the dark slide, to prevent any possible access of light to the plate, except through the lens.) The grand rule for timing the exposure may be stated to be—*"Expose fully for the details in the deepest shadows; the high lights will take care of themselves."* During the time of exposure never touch the camera or legs with the hand; it should be remembered that the human body vibrates, and that these vibrations will be communicated to the camera.

Should the picture happen to be taken outside the studio in windy weather, lull must be watched for, and the cap cautiously replaced on the lens during the gusts. A heavy stone suspended by a string from the top of the camera-stand will often check oscillation during exposure.

The same precautions in carrying the dark slide to the developing room or dark tent should be observed as those already given for carrying it to the camera.

DEVELOPMENT.

Having filtered the developer, if requisite, and placed the necessary quantity in the *clean* developing cup, the plate should

be taken out of the slide, and kept inclined in the same direction as that in which it has been carried from the camera, though the angle of inclination may be much modified. The *developer is then with an even motion and without stoppage* (the rim of the cup almost touching the film) swept over the plate till the latter is completely covered. As little of the solution as possible should be allowed to flow over the edges.*

The writer prefers to keep the long edge of the plate next to him, whilst the corner of the plate where any drainings may have accumulated is away from him. The plate is held with a *small* inclination downwards away from the body, and then the developer is applied as above.

The developer is worked round and round to each corner of the plate in succession till the image is fully out, which, if properly exposed, will take some half minute to effect. The deepest shadows alone should remain of the yellow tint due to the unaltered silver iodide and bromide. An under-exposed picture will take longer to bring out, whilst one over-exposed will flash out at once, and, unless the developer be immediately washed off, will appear to fade away and give a flat and fogged negative.

A properly exposed and developed picture should, by reflected light ("looking down on the plate"), appear as a well-defined and graduated image lying on a ground of silver bromo-iodide; whilst, by transmitted light ("looking through the plate"), every detail should be visible both in shadow and high light. With proper exposure the developer may remain on the film for a long time without injury to the image.

A plate-holder† is recommended for holding the plate during development. If not at hand, the corner must be held as described in the article on Coating the Plate (page 32); or else the plate may be supported in the centre by the tips of the fingers, though this is not recommended, as the warmth of the fingers communicating itself to the glass is apt to cause uneven development at those places. In developing large plates with-

* If the developer flow over the edge of the plate, it carries much of the free silver with it which is necessary to give density to the image. Some writers advocate the loss of this free silver. I cannot advocate it from theory or experience, excepting where too much vigour in the resulting picture is feared.

† Not that one which has been employed for holding the plate during coating collodion.

out the aid of a plate-holder, a support similar to that described at page 33 may be employed.

Some skilful photographers develop their pictures in a glass tray (see Appendix) slightly larger than the plate. The plate is carefully placed at the bottom, and the developer allowed to flow over it in one unbroken wave. The development of the image is watched through the glass bottom of the dish.

The following maxims are worthy of attention :—

1st.—Always have a weak and a strong developer in the field and in the dark-room.

2nd.—Think well as to which will answer your purpose the better, remembering that with a strong developer contrasts of light and shade are subdued, while with a weak one they are increased.

3rd.—Use your developer before it attains the reddish-brown colour, and do not use methylated in place of pure spirits of wine.

4th.—The less acetic acid used, the more harmonious will be the resulting picture.

5th.—Reject a negative which is either under-exposed or much over-exposed.*

INTENSIFICATION.

Practice alone can give the operator a knowledge of the exact amount of density required in a negative. Pictures are often spoilt by bringing up the half-tones to a nearly equal density with the highest lights. It should be recollected that the printing power of a negative not only depends upon the *quantity* of deposited silver, but also upon its *colour*. If a negative, on account of its density and colour of *deposit*, allow the *deepest shadows* to print to a depth verging on bronzing, and at the same time leave the *highest lights* white, or very nearly so, any further intensification will be detrimental.

The operator's judgment must decide whether he should use those intensifiers which cause increased deposit, or those which merely cause change of colour. The latter are best avoided

* It is too often the case that time is wasted in attempting to patch up a worthless negative. If the image appear unsatisfactory, and it be possible to expose another plate, obey Rule 5.

except under exceptional circumstances, or where an engraving or similar subject is being copied.

Should the former be decided upon, and if the picture has been slightly over-exposed, it is well to stop all further danger of development by treating it with a weak solution of potassium iodide and bromide for a minute or two. This will completely check all further action excepting that of intensification. A more common method of treatment is to fix the picture first, and intensify afterwards.

Intensification before fixing should be conducted as laid down for development. The intensifier should first be flowed over the plate, next the silver nitrate dropped into the cup, and then the intensifier from off the plate poured back. By this means a perfect mixture of the two is obtained. The intensification should proceed till the requisite density is arrived at, or till the solution becomes turbid if it be of iron, or deep brown if of pyrogallic acid. In the latter cases a fresh portion should be taken, and the intensification proceeded with till complete.

When intensifying with pyrogallic acid, it will be found advantageous (*should the exhaustive solution not be turbid*) to leave a little of the brown solution in the cup, and then to add a fresh portion to it. A more even and satisfactory action seems to be set up by this artifice.

In landscapes and in portraits the highest points of light alone should appear opaque before fixing.

If it be necessary to obtain more photographic opacity after fixing, it is advisable to use the iodine solution first (No. 4, page 23).^{*} This tends to prevent a red deposit forming on the shadows when the iron or pyrogallic acid formulæ are used. Intensification after fixing may be conducted in diffused light. It is more difficult to decide on the printing qualities of a negative which is intensified by change of colour. Practice alone can enable the operator to be sure that he has obtained the necessary opacity to the actinic ray.

FIXING THE NEGATIVE.

For sodium hyposulphite, a dipping bath or shallow flat dish may conveniently be used, or the solution may be flowed over

^{*} If the negative has dried before it be intensified, the edges should be varnished with Bates' Black Varnish, or run round with india-rubber solution (see page 58), to prevent the film leaving the plate.

the plate; if potassium cyanide be used, the latter mode of applying the fixing agent is advisable, and care should be taken to wash the plate directly all the silver iodide and bromide is dissolved away. The absence of these salts may be known by reversing the plate, and noting if the yellow semi-opaque colour has totally disappeared from the shadows.

After *development*, *intensification*, and *fixing*, the plate should be *well washed*.

DRYING AND VARNISHING THE NEGATIVE.

The plate may be allowed to dry either entirely spontaneously, or else by the application of heat. Quick drying, as before stated, gives an increased density to the image; if, then, part of a negative be allowed to dry spontaneously, and part by the aid of heat, the negative will not retain its proper relative gradation.

A neat appearance is given a negative when dry, and before varnishing, by scraping off the film round each edge of the plate to a distance of about one-eighth of an inch. This also prevents damp penetrating between the film and the glass plate, as the varnish coats both the margin and the film.

Before applying the varnish (see page 28), the plate should be warmed.* The varnish should be poured over the film like collodion over a plate, the same gentle rocking motion being given it whilst the excess is draining off. Any varnish collected at the lower edges may be removed by pressing them down on a pad of blotting-paper, after which the plate should be thoroughly heated. When cold it is ready for the printing operations.

The best source of heat is a moderator or paraffin lamp, the plate being moved briskly over the top of the chimney; the next is an ordinary fire, or a Bunsen burner with a rose; and the worst, the flame of a spirit lamp. In using this last, great care is requisite to prevent the flame setting fire to the solvent of the varnish.

It sometimes happens that the film tends to peel off and split whilst drying. The application of stale beer to the negative will prevent this fault. A weak solution of gum has been recommended, but gum has the property of absorbing moisture;

* The soft part of the back of the hand, between thumb and first finger, should just be able to bear the heat of the plate.

it swells, and causes the film to crack, the varnish being unyielding. Gum should, therefore, not be used, unless the negative is required to last but for a short time. A one per cent. solution of albumen in water is recommended as being the safest material to employ.

DEFECTS IN NEGATIVES, ETC.: THEIR CAUSES AND REMEDIES.

In the foregoing chapter the bare manipulations necessary for taking a wet-plate negative have been discussed, and very little notice has been taken of the defects that are likely to be met with in the various stages of operating. This chapter will be devoted chiefly to a narrative of the defects, and the remedies to be applied.

DEFECTS CAUSED BY THE GLASS PLATES.

If the negative, after development, appear to be fogged in certain places, while the remaining portions are bright, a dirty (*i.e.*, not chemically clean) plate may be suspected. If patches of the film are wanting in optical contact with the plate, as shown by the appearance of the same when looking at the reverse surface of the film, the suspicion is confirmed. The dirt may arise from improper cleaning of the plate with the tripoli powder or whitening (see page 5), or else from compounds unattacked by these detergents, such as the remains of corrosive sublimate (mercuric chloride) used in the intensification of a previous negative on the same plate.

The remedy in the first case is apparent; in the last case the plate should be washed well with water, and then steeped in nitric acid and hot water (one ounce to the quart is sufficient), and allowed to soak for twenty-four hours. This will probably cure the evil, after the plate has been thoroughly rinsed with cold water, and cleaned in the ordinary manner. Sulphuric acid and potassium dichromate, or a solution of cyanide, have been recommended. Practically, they do not appear to have any advantage over the nitric acid. Should this treatment fail, the plate may be coated with a solution of albumen, as described hereafter.

Circular and straight transparent markings are sometimes met with when a negative has been taken on a plate that has been put away as clean. Their occurrence leads to the suspicion that the plate has since become damp, or that a damp silk handkerchief or chamois leather has been used in polishing, or, perhaps, that one has been used which has been washed with soap, and has not been thoroughly rinsed afterwards.

Sometimes the collodion sets in streaks from one corner or edge, forming large ridges and furrows on the plate, which become only too apparent on sensitizing. Chips in the edges of the plates will cause this defect. The collodion clings to inequalities, and by molecular attraction small pools are formed, which finally run over on the plate, and cause the ridges. The remedy for this defect is to re-grind the edges of the plate carefully, or, if only one edge be defective, to pour off the collodion towards that edge.

Opaque streaks in a negative are usually due to scratches in the surface of the plate. There is no cure for this defect—the plate must be rejected. If round transparent markings of the size of a pin's head be apparent in the negative, when the glasses employed are new, a crystalline deposit on the surface of the plate must be looked for.

DEFECTS CAUSED BY THE COLLODION.

When the plate is taken out of the bath, should the film appear much less opaque at the end at which the collodion was poured on than at the lower end,*—1st, either the collodion has been allowed to set too long; 2nd, it has been prepared with too highly-rectified solvents, and ether in excess; or, 3rd, there is alcohol in excess, causing the plate to dry at the top before it has set at the bottom.

The remedies for the first cause are apparent; for the second, the bottle of collodion may be left unstoppered till the necessary amount of ether has evaporated, making up the quantity with alcohol, and then adding one or two drops of water to the ounce; for the third, the addition of a drachm of ether and a quarter of

* The portion of the image developed on these semi-transparent parts would be very feeble.

a grain of iodide of cadmium to the ounce of collodion will prove effectual.

The sensitized film may show opaque markings at the corner whence the collodion was poured off. This may be caused by too much iodide and bromide in the collodion, in which case, plain collodion should be added; or it may be caused by the collodion being too alcoholic. If the film be allowed to set more before immersion in the bath, it is probable that the fault due to the last cause will be corrected.

Should the defect noticed in the last paragraph be exaggerated, shown by the iodide almost completely leaving the film in places, the collodion is either not sufficiently porous, or else has been too highly iodized. In the former case water may be added little by little, and in the latter plain collodion.

A film sometimes refuses to "work," though it may appear dense and creamy. The finger should be rubbed lightly along one corner of it, and if the silver bromo-iodide rub off, both the above remedies may be applied, since it is evident the salt is only surface formed.

When a portion of the film leaves the plate with the bromo-iodide, it has not been allowed to set sufficiently before immersion in the bath; the water in the bath acts on the pyroxyline before it becomes gelatinous (from the evaporation of the ether and part of the alcohol), and the cotton is precipitated.

Curtains on the film have been noticed in "Coating the Plate" (page 32), and the reason there given of their existence. The cure was also suggested.

Markings in the film having the appearance of a fine network or crape arise from the use of too gelatinous a sample of collodion, or from a strong cadmium bromo-iodizer.* The remedy, in the former case (in which the plain collodion *per se* gives this structure), is to add a more limpid sample to it. If caused alone by the latter, keeping will probably rectify the evil; whilst if the result be from both causes, the addition of a limpid collodion iodized with an iodide of an alkali is recommended.

Should the developed image appear weak, and the film be opalescent, it is probable, if the collodion be in fault, that it is deficient in pyroxyline, either from sufficient not having been employed at first, or from a deterioration due to age.

* Solvents too largely diluted with water may also cause this defect.

A lack of half-tones in the image may be due to the use of a collodion whose pyroxyline has been made at too high a temperature, or by the iodine in it being liberated to excess.* The defect suggests the cure.

Should the film split on drying, it is probable that the collodion used contained too much ether. Pyroxyline made with too strong acids will also cause the evil. Mixing with another sample of collodion will probably be the best cure.

If the pyroxyline be made in weak acids, the film will generally adhere to the plate; but if it be of a gelatinous kind, it may leave it.

An under-iodized collodion will cause the developed image to appear flat and lacking in density. Try adding an extra grain of iodide of cadmium to the ounce. If the collodion be too highly *bromized*, and remain in the bath but a short time, the same defect will occur.

Opaque comet-like spots are sometimes to be met with in the developed picture. They usually arise from dust in the collodion, due to small particles of undissolved pyroxyline. The best remedy is to have a stock bottle for the collodion, and allow it to stand perfectly quiet. The upper portion may then be syphoned off and filtered (page 33).

DEFECTS CAUSED BY THE SENSITIZING BATH.

A line across a plate, seen after sensitizing, denotes a stoppage in the motion of immersion.

Lines in the direction of the dip are generally caused by the bath being too alcoholic. (Each time a plate is immersed the water absorbs a percentage of ether and alcohol). The excess may be removed by raising the temperature of the solution to about 200°. The alcohol is driven off in vapour at that temperature, whilst the aqueous solution remains behind. The solution may also be boiled down to half its original bulk, and be made up to the proper strength by the addition of purified water. These lines may also occur through the use of collodion which gives a very repellent film. This may be remedied by shaking it up with sodium carbonate, and decanting from the residue, or by adding to it one or two drops of water.

* Shown by the deep colour it assumes.

A scum on the film may be caused by the use of a bath containing too much silver nitrate. Test the strength of the bath solution, and add water, if requisite, filtering out any iodide that may be precipitated.

A scum may also be due to the use of a collodion too highly bromo-iodized; if this be the case, the latter should be mixed with a small quantity of plain collodion. Silver acetate is likewise a cause of scum which often may be seen floating on the surface of the solution. It should in all cases be filtered out, or be removed by drawing a strip of clean blotting-paper along the surface of the bath solution.

A bath carefully used will rarely get out of order. Sometimes, however, by accident, it may become contaminated by foreign matter, and then the negatives will be poor, flat, or, in some cases, useless, through fog on the shadows. To render the bath fit for work, resort should be had to the action of sunlight after neutralizing the acid with sodium carbonate or freshly precipitated silver oxide, as explained in the purifying of water (see Appendix). This is the best and, probably, the only legitimate cure for a bath that gives negatives of the foregoing description, except evaporating the solution to dryness, and fusing the silver nitrate. The addition of potassium permanganate has also been recommended. It is at the best a doubtful cure.*

Should these means fail, the best plan to adopt is to precipitate the silver, and make a new bath from it, as given in the Appendix.

There may be another cause of flatness in a negative, viz., the bath being below its proper strength in silver nitrate.†

Transparent pinholes on a negative, after fixing, are caused either by dust, or through the bath being over or under-iodized. Should they be caused by the bath being *over*-iodized, a granular appearance will be visible on the surface of the plate by reflected light. The granules are silver iodide‡ separated from the bath. The remedy for this is to take one-fourth of the bath solution and dilute it with three times its bulk of water. This

* Permanganate, fifteen grains; water, one ounce. This solution to be added to the bath till a faint permanent pink colour is given.

† A method of testing the strength of the bath is given in the Appendix.

‡ This is rather a debatable point. Some attribute them to silver sulphate, oxalate, or nitrate. The writer prefers leaving the paragraph as originally given.

will cause an emulsion of iodide, which can be filtered out. The solution may then be made of proper strength, either by boiling down, or by the addition of fresh crystals of silver nitrate. Another method, more recently proposed, is to add a few drops of hydrochloric (muriatic) acid to the solution, with constant agitation. This carries down the excess of iodide along with the chloride, but leaves the bath acid, from liberation of nitric acid. The addition of barium nitrate has also been recommended as a permanent cure for over-iodizing. In the experience of many operators it answers admirably. It has one defect, however, which is, that ferrous sulphate precipitates the barium as insoluble sulphate which gives a slight veil over the image; but varnish in a great measure restores the transparency. The following solution is recommended :—

Bath solution ... ..	...	...	...	1 ounce
Barium nitrate	...	...	...	5 to 10 grains

If necessary, the bath should be filtered after the addition of the barium salt is made. If the plate, after fixing, show signs of pinholes without the excrescences being previously visible, the bath is under-iodized. In this case more potassium iodide should be added.

Markings showing unequal density at its lower end may arise from the plate not being properly drained; or, if properly drained, from the dark slide being reversed from its proper position whilst carrying it.

Fog may be caused by the bath. A separate article will be given on this defect, its causes and cure.

When the bath is very acid, hard negatives, wanting in detail, often result. The acidity may arise from the use of collodion which has liberated iodine, and acidified the bath solution.* This may be remedied by adding an alkaline solution to the bath. Hardness may also be due to the development (see page 50).

Transparent flashes and curtains are generally caused by the free silver nitrate drying on portions of the plate, owing to the length of time elapsing between taking the plate out of the bath and developing it. Negatives are particularly liable to

* The iodine liberated combines with the nitrate of silver to form iodide of silver, and liberates, together with other products, nitric acid.

this defect if the bath be at all old and alcoholic. Careful draining, placing damp blotting-paper on the back of the plate in the slide, and other obvious precautions, should be taken.

Opaque markings, taking the form of lines, may occur through the bath solution collecting and running down the plate, particularly if the plate be not fully sensitized. The rivulets of bath solution complete the sensitizing of the plates in those portions alone, hence the image is stronger at those parts. The remedy is obvious.

Horseshoe-markings, of about the size of a small pearl button, may occasionally be met with when a collodion is used which appears opalescent after sensitizing. They arise from the reflections from the small drops of bath solution that accumulate on the *back* of the plate. It is needless to enter into the exact cause of the horseshoe form; but it can be rigorously demonstrated as resulting from the shape and motion of the drops. By carefully wiping the back of the plate before placing it in the slide this trouble will cease.

DEFECTS CAUSED BY DEVELOPMENT.

Lines may occur on the negative by the stoppage of the developer when poured over the exposed plate. The stoppage is generally the result of carelessness, but it sometimes may be due to drying of the film after removal from the bath, in which case more than ordinary of the developer must be taken to enable the plate to be properly flooded. The free silver nitrate having partially dried on the film, but little will be carried away by the developer. The defect may also arise from the repulsion between the free silver nitrate on the film and the developer, either through excess or defect of alcohol.

Lines may also be caused by leaving in the developing cup a small quantity of water, which will not readily mix with the alcoholic developer, thus causing development to be delayed on those portions of the negative with which it happens to come in contact.

A poor and flat image may arise from washing off the free silver nitrate from the plate by the developer; from the use of too strong a developer; from the bath or collodion, as explained in the two previous articles; or from over-exposure.

In addition to negatives becoming hard from faults in the

collodion or bath, they may have the same defect from being developed with a weak developer, from one with too much acid in it, or from under-exposure. The first two causes may arise from the ferrous sulphate having changed to the ferric state, as explained in page 21.

A scum forming on the developer during development may denote a want of acetic acid in the developer.

DEFECTS CAUSED BY INTENSIFYING AND FIXING.

The chief defects that arise through intensifying are those which may also occur in development. Fog and a red deposit on the shadows are chiefly to be anticipated. The former may occur before fixing if the pictures be over-exposed; the latter, both before and after fixing, by the addition of too much free nitrate of silver to the intensifier; or again, after fixing, by the imperfect washing of the film before the intensifier is applied. The red stain will generally yield to

Glacial acetic acid	...	...	...	1 ounce
Water	...	...	...	1 "

Fog may be reduced as given at page 53.

It should be noted that the larger the amount of silver added, the more rapid will be the intensification; but the half-tone will not be brought up proportionately to the high lights. The smaller the quantity of silver used, the greater will be the comparative force given to them, and the longer time it will take to get proper printing density. Thus, a negative lacking in contrast may be corrected by using an intensifier with large, and one too rich in contrast with small, doses of silver.

The defects caused by fixing are few in number; the chief is that caused by the potassium cyanide eating away the half-tones, through the washing being too long delayed. If strong cyanide be used, and it be allowed to stop in its flow over the plate, a line of weak density may become apparent. A film splitting after varnishing may often be traced to the use of sodium hyposulphite as a fixing agent followed by an imperfect washing.

DEFECTS CAUSED BY VARNISHING.

Several defects may arise in varnishing. First, and most serious, the collodion film may dissolve away. This is caused

by the solvent used in the varnish being impure and of a low specific gravity. The addition of a small quantity of water may effect a cure, or varnishing the plate cold, and *then* heating it, may answer in some cases.

Should a transparent mark show across a negative immediately after varnishing, it is probable that the solvents are *slightly* too strong, and that the varnish has not been allowed to flow over the film without stoppage. The cure suggests itself.

Ridges in the varnish on the film *may* denote that too much of the solvent has been allowed to evaporate by repeated applications to other plates; in which case add more spirits of wine (.830 methylated will answer). Ridges may also arise through rough edges of the plate, or from dust on the film. Varnish may crack through swelling after it has been applied to the film, and give blisters, or it may do so through the use of bleached lac.

If from any cause it should be desired to remove the varnish from a film, it should be subjected to the vapour of alcohol; or weak alcohol may be flowed over the plate five or six times, warming the plate as if for varnishing between each application. A solution of caustic potash will also be effectual, and leave the image in its original state, after which it may be re-varnished. Varnish may also contract; this is probably through the use of copal in its composition. Should the varnish dry matt, it is probable that sufficient heat has not been applied after coating the film with it. If it dry matt in parts, it is probable that the preliminary heating of the negative has been unequal.

Other small defects may sometimes be noticed. A little thought will generally trace their cause, and suggest the remedies.

DEFECTS CAUSED BY THE DARK SLIDE.

Should it happen that at one or more corners of the plate the silver is reduced on development, so as to cause opaque marks, the slide should be examined. The evil may arise through the wires which support the plate not being made of *pure* silver. A coating of varnish applied to them will prevent future mischief.

Opaque streaks seen after development, running from a

corner, may denote the ingress of light into the slide, or they may be due to the fingers touching the film during development.

Transparent marks of the size and shape of a pin's head, with a very small opaque dot in their centres, may show that dust has fallen from the front of the dark slide on to the film. The inside of the slide should be carefully wiped out with a damp cloth. Similar spots may arise from the use of collodion made with a pyroxyline which has been prepared with dilute acids (see page 8), though in this case the central dots are generally not visible.

FOG ON WET-PLATE NEGATIVES.

Fog or a veil over a negative being one of the commonest defects met with, it may be useful to point out the method to be adopted to detect its origin.

Over-exposure in the camera is one of the most common of its causes, particularly when working with newly-iodized collodion.

The contamination of the silver nitrate bath with organic or foreign matter may also give rise to it. It is easy to account for foreign matter in the bath, the dust and other impurities that float in the atmosphere of the dark room being one source. Distilled water may also contain it, as ordinary stills are frequently used for distillation other than that of water. A bath made of impure gutta-percha* may also account for its presence, as will the wooden case of a glass bath, if the bath solution happen to touch the wood whilst being poured in or out. In all these cases sunning the bath solution, or evaporating it down to dryness, are the most effectual remedies. Potassium permanganate may be employed as a corrective, but, as before stated, is not recommended.

Alkalinity of the bath will be certain to cause fog. The cure in both cases has been given, under the head of the "Sensitizing Bath" (page 16).

Diffused light in the dark-room, in the camera, or through the lens, will cause a foggy picture.

Vapour of ammonia, the product of the combustion of coal-gas, and sulphuretted hydrogen, are also inducive of fog. All these vapours may be detected by their smell.

* Gutta-percha is often adulterated with magnesium salts, &c.

The omission of the acetic acid in the developer (or the presence of too small a proportion) will cause the evil, as also a very high temperature in the dark-room.

Many filter papers contain iron, and other impurities, which may induce fog.

TRACING THE CAUSE OF FOG.

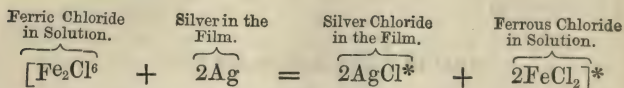
Should a negative appear fogged, another plate should be sensitized, and reduced exposure given it; if this fail to effect a mitigation of the evil, the bath should be tested for acidity or alkalinity, as shown at page 16. If the bath be of the right acidity, a plate should be sensitized and kept for two or three minutes in the dark-room. It should then be developed, and the presence of fog will indicate (supposing no hurtful vapours be present) either organic matter in the bath, or diffused light in the dark-room. Another plate, similarly treated in a really dark room, will show if it be due to the latter cause. If, however, it be proved that there is no filtration of actinic light into the dark-room, another plate should be sensitized and placed in the camera. The front board of the slide should be withdrawn as usual, but the cap of the lens should not be removed. The plate should next be flowed with the developer in an absolutely dark room. If fog be still apparent, the bath is at fault. If the bath be new, it may be that there are vapours present which cause fog, or it may be due to alkalinity.

If neither the bath nor the atmosphere be at fault, and if fog be present, diffused light is admitted into the camera; if absent, it is probable that the fogged negative was due to the bad lighting of the subject, or to diffused light through the lens, as in the case in which the sun is allowed to shine directly on it, rendering the glasses slightly luminous.

To render a slightly-fogged negative fit for printing, a solution of iodine and potassium iodide (page 23, No. 4) may be applied to the film, and the silver iodide dissolved away with potassium cyanide. With one or more applications of the iodic solution the veil may often be removed without injuring the density of the negative. Another method of reduction is by using the following in lieu of the iodic solution:—

Saturated solution of ferric chloride	...	1 drachm
Water	... ..	1 ounce

This is floated over the negative, and, after washing, the cyanide is applied. By this method the deposit on the shadows seems to be more attacked than that on the lights; it is consequently to be preferred.



The silver chloride is dissolved away by the fixing agent. Very dilute nitric acid may also be applied to the film, but this requires very delicate handling. The acid should be diluted with ten times its bulk of water.

POSITIVE PICTURES BY THE WET PROCESS.

With positive pictures the great desideratum is to obtain as white a deposit of silver as possible, so that efficient contrast between the black or dark backing may be obtained. The bath itself is not required to be so strong, but the collodion may be the same, as that employed for negative work.

The formula for the sensitizing bath is—

Recrystallized silver nitrate	...	...	300	grains
Nitric acid...	...	...	$\frac{1}{4}$	min.
Water	...	...	10	ounces

The bath is prepared precisely as given for the negative bath at page 14.

The following developers are efficient: the pyrogallie acid developer (on page 18), and

Ferrous nitrate	...	...	110	grains
Ferrous sulphate	...	...	60	"
Nitric acid	...	...	20	minims
Alcohol	...	...	quant.	suf.
Water	...	...	4	ounces

The ferrous nitrate may be prepared by taking barium

* It seems as if subchloride was also partially formed by the ferric chloride. The general equation, however, holds good.

nitrate 130·5 grains, dissolving it in 2 ounces of water, and adding to it a solution of 76 grains of ferrous sulphate in 2 ounces of water. A precipitate of barium sulphate falls, which must be filtered out, and 110 grains of ferrous nitrate are left in solution. The nitric acid should be dropped carefully in, the 20 minims being previously diluted with half an ounce of water. The alcohol is then added, *after* the 60 grains of sulphate of iron have been dissolved.

The nitric acid causes the silver to deposit with a white lustre by reflected light, and this developer is consequently very effective for the purpose required. The image should be fixed with the ordinary cyanide fixing solution given at page 27.

When the picture is taken on a ferrotype plate nothing remains but to varnish it with ordinary colourless varnish; but it must be recollected that in this case the image is reversed.

When a glass plate is employed the film side may be varnished with Bates's Black Varnish, in which case the image will appear in the natural position of the object.

A good black varnish is made as follows :—

Asphaltum	4 ounces
India-rubber solution, as supplied for tele-	
graphic purposes	1 fluid ounce
Benzole	12 ounces

The manipulations in positive pictures are similar to those for negatives, and need not be described again. Ferrotype plates (which are thin iron plates enamelled or japanned with a chocolate brown medium) are cleaned with a little *dilute* potash, followed after with dilute nitric acid, and a final wash in distilled water. They are then allowed to dry, and rubbed over with a chamois leather or silk handkerchief, if requisite.

DRY PLATE PROCESSES.

THERE are certain manipulations common to all dry plate processes, and it is proposed to detail them here instead of repeating them with each process. 1st. The plate is cleaned. 2nd. It is given a substratum, or edging, to cause adhesion of the film during development. 3rd. The plate is coated with collodion and sensitized; or it may be coated with collodion containing the

sensitive salts in suspension. 4th. It is coated with a preservative after washing. 5th. It is dried. 6th. It is exposed. 7th. It is developed. In regard to the theory of dry plate processes there is little difference to that already given under the heading of wet plate processes as regards any of the operations except 2nd, 4th, 5th, and 7th. In these there is a variation to which it is as well to draw attention.

EDGING THE PLATE, OR GIVING IT A SUBSTRATUM.

A plate may be edged with albumen, gelatine, or india-rubber; or the surface may receive a fine coating of any of these bodies, in order to cause adhesion of the film to it during development and subsequent treatment. All of these bodies adhere firmly to glass, and also to collodion, and the fine layer, or edging, the plates receive acts similarly to a mordant in dyeing. It is not always absolutely necessary, when working dry plates, to give either edging or substratum; but, as a rule, it is advisable.

When a substratum is to be given to the plates they should not be polished by the silk handkerchief. It is better to soak them first in potash, then in a dilute solution of nitric acid, and finally to rinse them thoroughly in pure distilled water. They should then be placed in a rack on clean blotting-paper, and be allowed to dry spontaneously. If albumen be employed as the substratum, the following solution should be made up:—

Albumen	...	...	1 ounce (white of one egg)
Water	...	...	50 to 100 ounces
Liquor ammonia	...	...	5 drops*

The albumen and water should be well shaken together in a bottle for five minutes, and then filtered through fine filter paper or well washed tow. The funnel should be lowered nearly to the bottom of the beaker into which the albumen is filtered, to prevent the formation of air-bubbles.

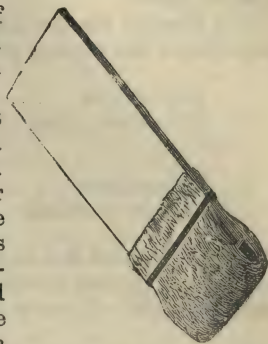
Another formula is here given for use with the dried albumen as supplied by photographic chemists:—

Dried albumen	...	...	...	50 grains
Water	...	...	...	50 ounces
Liquor ammonia	...	...	...	5 drops

* Three or four drops of commercial carbolic acid may be substituted for the ammonia.

The albumen may be dissolved by the aid of heat not exceeding 120°. The solution is filtered in the same manner as the above.

The most convenient method of applying albumen is that employed by Mr. Valentine Blanchard. A brush is made of swan's-down calico, as follows:—A strip of glass, about six inches long by two broad, should be procured, and round one end should be attached, by means of thread or by an india-rubber band, a double fold of swan's-down calico. This brush should be dipped in the albumen, and the excess squeezed out against the beaker. The plate should then be brushed smoothly down



the surface in parallel lines to within one-eighth of an inch of its edges, set up to dry on blotting-paper, and protected from dust. When dry (which it should be allowed to do spontaneously), the plate will be ready for the collodion.

Some prefer to flow the plate with the albumen solution. This is best done on a plate which has been well cleaned but not polished, and which has been subsequently moistened with distilled or rain water. Whilst still wet the albumen should be flowed over the surface as in coating a plate with collodion, and the surplus fluid returned to the stock bottle through the filter. If this plan of giving a substratum be adopted, the solution should only contain fifty ounces of water to one ounce of albumen.

Another substratum, which gives even better results than the albumen, is the following:—

Sheet gelatine...	...	...	...	75 grains
Distilled water	...	...	...	60 ounces
Ammonia	...	...	...	$\frac{1}{4}$ ounce

The gelatine should be first softened in 30 ounces of cold water, and then dissolved by adding the remaining 30 ounces of water to it in a boiling state. When cool, the ammonia should be added, and afterwards the solution should be filtered. It is advisable to make it up fresh as required. The addition of one ounce of alcohol

has been recommended; the writer has failed to obtain any practical advantage by its employment. The substratum is applied as directed above.

The formula for the india-rubber solution (which should be poured over the cleaned plate like collodion) is—

India-rubber	...	...	...	...	1 grain
Chloroform (commercial)			...	...	1 ounce

Or,

India-rubber	...	..	...	...	1 grain
Benzole (rectified)	...	...	...	...	1 ounce

It will be remarked that all of these solutions are very dilute. If they were of greater strength it would be found that they were excessively liable to cause blisters in the collodion film.

THE COLLODION TO BE EMPLOYED.

The collodion to be recommended is such as will give by the wet process a brilliant and intense negative. The film should not be horny, whilst, on the other hand, it should not be of that character which admits of being easily torn. The writer has found that the addition of water to it causes a greater sensitiveness, doubtless owing to the porous state in which it is left. The following procedure may be adopted:—Take half the collodion to be used in dry plate work, and drop into it distilled water to such an amount that on coating a plate the film appears slightly reticulated. The remaining half should then be mixed with it, and, as far as the physical nature of the collodion is concerned, it will be found in good condition.

It may be advisable to prepare collodion separate for some processes, and if so the pyroxyline should be prepared at high temperatures. This is specially the case with certain emulsion processes. The following is a description of its manufacture, which, for details, must be read in conjunction with those given at page 6.

The formula is that published by Mr. L. Warnerke, and due to Col. Stuart Wortley. One hundred grains of the finest cotton wool (prepared as given at page 7) are put into a porcelain jar, and thirty grains of gelatine dissolved in the smallest amount of water are added. By pressing it with a wooden stick all the

cotton will be uniformly impregnated. It is subsequently very thoroughly dried before the fire.

Nitric acid (sp. gr. 1.450)	...	4 oz.,	or sp. gr. 1.42...	35½ dr.
Water...	...	12½ dr.	ditto	... 9 dr.
Sulphuric acid (sp. gr. 1.840)	...	6 oz.	ditto	... 6 oz.

are mixed in the order named, and, by means of a water bath, the temperature is kept up to 158° Fah. The dried gelatinized cotton, weighing about 130 grains, is immersed in the mixed acids for about twenty minutes. Here it should be observed that with some cotton it is impossible to preserve this temperature, as the slightest tendency to dissolve at once raises it rapidly, and the cotton speedily disappears. With such a sample of cotton the temperature must be lessened to such a degree that this result does not obtain, and less water must be added. The pyroxyline is now washed and dried, as in the preparation of the other pyroxyline. The addition of the gelatine to the cotton causes the formation of nitro-glucose when in the acids, and most of this is lost in washing. The writer *recommends the omission of the gelatine* from the above formula, and if any organic matter is required, nitro-glucose may be added direct to the collodion.

SENSITIZING AND WASHING THE PLATE.

The bath should be such as will give a good negative by the wet process. It should be of the strength of about 40 grains of silver nitrate to the ounce, unless highly bromized collodion be employed, in which case it may be of the strength of from 60 to 80 grains to the ounce.

Washing the Sensitive Film.—After sensitizing, it is necessary to eliminate the free silver nitrate from the film. The following method will be found efficient. Two flat dishes or dipping baths should be filled with distilled or purified water, and immediately after the plate is taken out of the bath it should be placed in one of them. It is of great consequence that the plate should be immersed in the water without stoppage. When using a flat dish a certain knack is required to effect this. The most successful method is to hold the plate nearly touching the surface of the water, and then to allow the plate to sink by its own weight. With a little practice, an even circular wave moves over the surface, and there will be a consequent freedom from markings due to this part of the preparation.

When the ether and alcohol have been absorbed by the first washing (which is known by an absence of all "greasy" appearance on the surface), the plate should be removed to the second dish or bath, and be allowed to remain at rest for four or five minutes.* It is then washed under the tap for a couple more, and finally rinsed with distilled water, when it will be ready for the preservative.

THE PRESERVATIVE AND ITS MODE OF APPLICATION.

At page 3 it was stated that a preservative was used to absorb the iodine and bromine liberated by the action of light from the silver iodide and bromide present in the film. It has other uses, however, the chief one being the prevention of the access of the atmosphere to the sensitive salt. Without such protection the latent image would become iodized, and, consequently, undevelopable.† The preservative is usually applied by floating it on the surface for about a minute. It is a good plan to allow the solution from one plate to flow back into the cup, and to use it for the first flowing of the next plate, and then to apply fresh. By this means dilution from the water on the surface of the film is avoided. Some operators, in certain cases, apply the preservative by immersing the plate in a flat dish or dipping bath, containing the solution. As a rule, this procedure is not to be recommended, as any contamination from one plate is liable to be carried on to another.

DRYING THE PLATE.

After applying the preservative the plate is usually dried spontaneously,‡ or by the aid of heat,§ the temperature being maintained below 212°.

To the photographer who works with home-made dry plates

* If the plates are required to be kept but a short time (say three or four weeks), a minute's washing under the tap is sufficient. The plate will be rather more sensitive than if the washing be prolonged. In the case where the preservative is washed off, the minute's preliminary washing suffices.

† For further explanation see "Emulsion Processes in Photography," by the writer. (Piper and Carter.)

‡ The plate should never be altered in position whilst drying, for if it be, a mark is sure to appear round the portion only partially desiccated.

§ The maintenance of an even temperature for drying the plate is of the greatest importance.

a perfect drying-box is a *sine qua non*. It may be taken for granted that the larger the box the more even will be the drying of the plates, and consequently the better chance of perfection in the negative.

An ordinary cupboard may be converted. The shelves at the back edge should be pierced with holes close together, or an interval left between them and the back of the cupboard. About two and a-half inches from the back, small tumblers* (such as described for developing cups) should be let into the shelf, the rim projecting about half an inch above the shelf itself. Small strips of glass should then be fastened round the cupboard, at such a height that when the corners of the plates which are to be dried rest in the tumblers, the opposite corners should rest against them. Ventilation should be secured by boring holes at the top and bottom, covering them with strips containing L-shaped holes. The accompanying diagram shows the form. A A is the top of the cupboard; B B, the strip of wood screwed on to cover the aperture O. The inside of the L-pieces and the side of O should be blackened, to prevent any reflection of light. If hot-water or hot-air pipes can be passed through the cupboard, the rapidity of drying will be increased. In this case, over the pipes, and at a distance of six inches from them, should be placed a sheet of perforated zinc. This will equalize the distribution of the heat to a great extent.

Another good plan for obtaining heat is to erect a cupboard (as

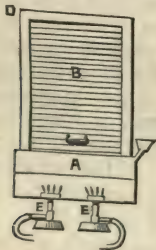
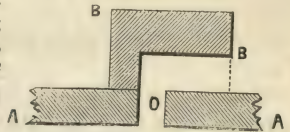


Fig. 1.

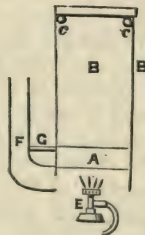


Fig. 2.

described above) over a flat and closed galvanized iron bath.

* The small porcelain ink pots used for school desks are equally good.

Fig. 1 (page 61) gives the elevation, and Fig. 2 the section. A is the bath, D the cupboard, which may conveniently be closed with a roller shutter,* B, passing over *c c*, and is weighted by a bar of lead, so as to nearly balance the weight of the shutter when closed. A couple of Bunsen gas-burners, E E, heat the water in A; the steam generated is carried up the flue F, which also carries off the products of the combustion of the gas. Inside the cupboard an even temperature is thus maintained, and the plates dry satisfactorily. Ventilation may be secured as in the first-named drying-box. If any of the drying cupboards described in the "Dark Room and its Fittings" be not available, any ordinary light-tight and large box may be temporarily used. The plates should be ranged round the box, one corner only resting on the bottom. Two or three thicknesses of blotting-paper should be placed near the supported corner to imbibe the drainings.

BACKING THE PLATES.

Blurring, or halation, in a negative, is a kind of "halo" effect, which is seen on a deep shadow when in close contiguity to an intensely high light. Thus, when dark trees are taken against a bright sky, the light of the latter appears to encroach on the tops of the former. Some classes of dry plates are particularly liable to this defect, and there are two causes to which this can be attributed: the first is the dispersion of light from the minute particles of the collodion and the sensitive salt; and the second is the reflections and re-reflections of the light from the surfaces of the plate. To minimize the effect due to the first, it has been suggested to dye the film with a body such as aurine. This is not advisable, as from the nature of the remedy sensitiveness must be diminished to a great extent. A very transparent film, as is produced in certain albumen processes, or a very dense film, are both less liable to blurring from dispersion of light than if the film be of only medium density. If the reflections from the back surface of the plate could be converted into a non-actinic colour, their action would be *nil* on the film. This can be partially effected by applying some non-actinic colour, such as

* The shutter may be made of American leather, covered over with one quarter-inch strips of oak or well-seasoned pine. The shutter should fit into a groove formed along the sides and bottom of the front of the cupboard.

gamboge, burnt sienna, &c., to the back of the plate. Should it be proposed to coat the back of the plate, the following will be found to answer well:—

Powdered burnt sienna	....	...	1 ounce
Gum	...	...	1 "
Glycerine	...	...	2 drachms
Water	...	...	10 ounces.

The solution is to be brushed in with a hog's-bristle brush. Ordinary printing paper, coated with a solution of gum-arabic to which a little glycerine has been added, and stained with Judson's orange or crimson dye, when applied to the back of the plate, is perhaps the cleanest method of giving a backing.

DEVELOPMENT.

There are various methods of developing dry plates, but some are in more general use than others. When any special mode is to be adopted with any process, it will be indicated. The first point to be attended to before developing is to give an edging of india-rubber solution to the film, if no substratum or edging have been applied to the plate. This is conveniently accomplished by using the appliance shown in the accompanying sketch. A piece of wood nearly square in section, and of about a quarter of an inch side, is cut in the shape shown. A narrow strip of swan-down calico is tied over the end, leaving the sides A and that opposite to it uncovered. The calico is charged with india-rubber solution from a bottle, and the notch applied to the edge of the film, the projection supplies the solution to the edge of the film, and the part B prevents any encroachment on the plate. This method secures the complete sealing of the film to the edges of the plate. For edging plates, about five grains of india-rubber should be dissolved in one ounce of benzole, using india-rubber paste as the basis.



After the solvent of the india-rubber has evaporated, which it does rapidly, the plate will be ready for moistening. The operator should now consider whether water can be at once applied, or whether a preliminary application of spirits of wine would be advisable, remembering that it is no use applying the latter if the preservative be not soluble in it.

If the preservative used for the dry plate contain any substance only slightly soluble in the former, but more readily in the latter, then the latter should be flowed over the plate and allowed thoroughly to permeate the film. A good washing under the tap afterwards is then necessary. If the preservative contain nothing soluble by alcohol, water should be applied in the first instance.

Whether spirits of wine or water be the agent used for softening the film, great care should be taken that there is no stoppage in the flow, otherwise markings in the negative may become apparent. (A dipping bath or a flat dish is useful when water is to be applied.) The preservative in most cases should be washed off from the film as far as possible before development commences.

The rationale of the method of developing the invisible image has also been given at page 17, when it depends upon the oxidation of the developing agent, and the consequent reduction of the free silver nitrate that may be present. With dry plates, and on some occasions with wet plates, there is another system pursued of calling forth the invisible image, and this mode of development is known as the "alkaline development." The silver compound to which it is usually applied is the bromide. When silver bromide is exposed to light, we have the formation of a certain small quantity of silver sub-bromide. If pyrogallie acid be applied to this, it will be found that scarcely any developing action takes place, even after prolonged contact, but that if a drop of weak ammonia be added, a blackening of the exposed parts at once takes place, and analysis shows that metallic silver is formed.

The silver sub-bromide is itself a dark-coloured body, and if the exposure be given so as to produce no visible discolouration, the same blackening by the developer will take place, which indicates that not only those particles which are acted upon by light get reduced, but those adjacent to it are likewise affected. Experiment has shown that silver bromide does not exist in molecular contact with metallic silver, hence the moment the silver sub-bromide is attacked and reduced to the metallic state, at once fresh silver sub-bromide is mechanically formed, which, in its turn, is ready for reduction by the developer. Now experiment proves that silver sub-bromide is more readily attacked by the alkaline solution than the ordinary bromide; hence we can trace the reason of the development of the image. Again,

in the formulæ it will be noticed that a soluble bromide is recommended to be added to the solution of pyrogallie acid and ammonia. This is to check the reduction of the unaltered silver bromide, the soluble bromide seemingly forming a compound with it, which is practically unattachable by the developer.

The action of the alkaline pyrogallie solution is as follows, the developer having been analysed as to its constituents:—The silver bromide is split up into silver and bromine, which is at once absorbed by the ammonia to form ammonium bromide, and the oxygen of the ammonia combines with the pyrogallie acid, some intermediate actions taking place. From analysis it is shown that a weak solution of alkaline developer reduces less silver sub-bromide than a stronger one, and practically this is also found to be the case, since an image developed by strong solutions is always more intense than that developed by a comparatively weak one.

A new developer made by dissolving ferrous oxalate in a solution of neutral potassium oxalate (see page 67) acts even more energetically than the alkaline pyrogallie developer. The theory of its action is presumably somewhat similar to that of the latter.

The following are 'standard formulæ for dry plate developers:—

I.—*Iron (Acid) Developer.*

No. 1.—Gelatine (any kind will answer)...	64 grains
Glacial acetic acid	2 ounces
Water	14 „
No. 2.—Ferrous sulphate	30 grains
Water	1 ounce.

Half the quantity of the water in No. 1 should be taken, and the gelatine allowed to soak in it till it be thoroughly swelled. The remaining half of the water should be added in a boiling condition, which will cause solution. The acetic acid should next be added, and the whole allowed to cool.

One part by measure of No. 1 should be mixed with three parts of No. 2, and then filtered. It is inexpedient to *mix* more than is necessary for one or two days' use, as the iron undergoes oxidation. No. 1 will keep indefinitely, whilst No. 2 should be made as required.

To every drachm of developer used, one minim of a solution of silver nitrate (30 grains to the ounce) should be added just previous to its application to the plate.

II.—*Plain Pyrogallie Acid Developer.*

Pyrogallie acid	...	...	...	3 grains
Water	...	...	...	1 ounce

To bring up the image to printing density, the following is applied with three or four drops to each ounce of a solution of silver nitrate (30 grains to the ounce of water):—

Pyrogallie acid	...	...	...	2 grains
Citric acid	...	...	...	$\frac{1}{2}$ grain
Water	...	...	...	1 ounce

III.—*Acidified Pyrogallie Acid Developer.*

The developing solutions are—

No. 1.—Pyrogallie acid...	...	...	144 grains
Alcohol...	...	...	2 ounces
No. 2.—Silver nitrate	...	...	60 grains
Citric acid	...	...	60 „
Distilled water...	...	...	3 ounces
Take of No. 1	...	...	16 drops
No. 2	...	...	8 „
Water	...	...	1 ounce

Flow this over the plate till the detail is well out, when five or six drops more of No. 2 must be added to give intensity.

IV.—*Alkaline Developer.*

No. 1.—Pyrogallie acid	...	...	6 grains
Water	...	...	1 ounce.
No. 2.—Potassium bromide	...	...	20 grains
Water	...	...	1 ounce.
No. 3.—Ammonia (.880)	...	...	1 part
Water	...	...	32 parts.

To every two parts of Nos. 1 and 2 one part of No. 3 is added. It is well to flood the plate for a second or two with the mixture of Nos. 1 and 2 before adding No. 3. This prevents irregularity in development.

V.—Another form of *the same developer* is as follows:—

No. 1.—Pyrogallie acid	...	...	96 grains
Methylated alcohol	...	...	1 ounce
No. 2.—Potassium bromide	...	...	12 grains
Water (distilled)	...	...	1 ounce
No. 3.—Ammonium carbonate	...	...	80 grains
Water (distilled)	...	...	1 ounce

Or,

Liquor ammonia	...	...	25 minims
Water	...	...	1 ounce

To develop the plate, take of—

No. 1	...	...	...	1 part
No. 2	...	...	...	2 parts
(Half the quantity in cold weather.)				
No. 3	...	...	...	4 parts

The alkaline developing solutions, of either No. IV. or No. V. formulæ, should be mixed immediately before use, and, after well stirring with a glass rod, be flowed over the plate. When the detail begins to appear, the bulk of the solution should be poured back into the developing glass, and the appearance of the image watched. If the detail appear slowly and regularly, the developer should be again flowed on the plate, and the image be allowed to gain full intensity. If, however, it appear very slowly, and with apparent difficulty, another drachm of No. 3 should be added to the solution in the glass, and again be applied to the film. If the detail flash out at once, the action must be instantly checked by water, and another half drachm of No. 2 be added to the developing solution, which should be again applied.

The next developer, and that one which seemingly will become a general favourite, is the ferrous oxalate developer, first formally introduced by Mr. W. Willis, Jun., though Mr. Carey Lea pointed out previously that it could be used. To prepare the developer, make up—

Ferrous sulphate... ... A saturated solution.

Next add to it sufficient oxalic acid (a saturated solution) to cause all the iron to be precipitated as ferrous oxalate, which is

of a bright lemon colour, and very heavy, sinking rapidly to the bottom of the vessel.

The ferrous oxalate must, of course, be washed, and, since it is heavy, this can be readily accomplished by the method of decantation. The supernatant fluid is carefully poured off, and the vessel is then filled with fresh water (tap water will answer), which, after well stirring, is poured off, and the vessel filled up again. This washing may be considered to be complete after six changes of water.

A saturated solution of the neutral potassium oxalate is next required, and this can be prepared by adding a saturated solution of caustic potash to a saturated solution of oxalic acid, till a very faint blue colouration is given to red litmus paper. A crystal of oxalic acid is then added, and the neutral solution will be formed.

The ferrous oxalate is next thrown into the warm potassium oxalate solution; only so much of the oxalate being added as to leave a slight portion of the ferrous compound undissolved. The solution will be of a deep red colour, and, when cold, should be filtered free of all deposit. It is then ready for use. In our own experience, it is better to add a grain, or even three grains, of potassium bromide to it immediately before use, since, unrestrained, it has an undoubted tendency to fog the picture. If this addition be made, the negative will develop bright and clean.

Where proper exposure has been given, it may be used of full strength, but where over-exposure is suspected, it should be of only three-quarter strength; that is, to each three drachms of it one drachm of water should be added.

The exposure required for this developer seems to be about two-thirds of that required for the alkaline developer given above, and is, therefore, a decided gain to the photographer.

There is a great charm, also, in it, the plates gaining intensity steadily, and without any tendency of being overdone, and the negatives give brilliant prints.

The ferrous oxalate becomes oxidized if it be left in contact with the air. It is, therefore, perhaps advisable to make up more of it than is necessary for two or three days' supply. Mr. Swan, however, states that a bundle of bright iron wire kept in the solution will prevent its losing its developing power; and Mr. Woodbury recommends the addition of a pinch of fresh ferrous oxalate, when in the inactive state, to restore it. On the

whole, we recommend the solution to be made up merely as required, since it can be speedily prepared by keeping in stock a saturated solution of potassium oxalate and dry ferrous oxalate.

There is another developer, introduced originally by M. Sammann, of Paris, which is popularly called the "hydrosulphite developer." It has not been much employed, owing to the trouble there is in making it. It is, however, very effective, and Mr. Berkeley, an advanced emulsion worker, recommends it strongly.

We give M. Sammann's latest directions. Make the following stock solutions:—

- | | | | | | |
|---|-----|-----|-----|-----|-----------|
| 1.—Pyrogallic acid | ... | ... | ... | ... | 1 ounce |
| Saturated solution of salycic acid in water | | | | | 20 ounces |
| 2.—Sodium bisulphite | ... | ... | ... | ... | 1 ounce |
| Sodium sulphite | ... | ... | ... | ... | 80 gr. |
| Water | ... | ... | ... | ... | 4 ounces |

20 grains of sodium borate may be substituted for the sodium sulphite.

When it is required to make the sodium hydrosulphite, a vial is half filled with granulated zinc, and enough of this solution is poured in to fill up the interstices. After half an hour the reaction is complete. The solution is poured off into a stoppered bottle, where it will keep, but only for a few hours.

The zinc and vial must be well washed in order to be ready for the next quantity which may be required. M. Sammann says that the bisulphite must be quite free from sulphurous acid, which, if present, must be neutralized by sodium carbonate. One part of it should dissolve in two parts of water at the ordinary temperature.

Before development, the plates are flooded with a solution of—

- | | | | | | |
|----------|-----|-----|-----|-----|-----------|
| Tannin | ... | ... | ... | ... | 10 grains |
| Water... | ... | ... | ... | ... | 1 ounce |

They are then washed and drained. One part of No. 1 and four parts of No. 2 are then mixed together, and placed in a dish containing the plate, which it is just big enough to hold. When all the detail is well out, it is probable that the negative will have sufficient printing density, as the development is very slow and gradual. If the pyroxyline be of too "organic a

character, a white veil is sometimes seen on the shadows, which, however, disappears on varnishing. The intensity, if lacking, may be given in the usual manner by pyrogallie acid and silver, according to the formula given at page 66. Mr. Berkeley states that this developer may be made alkaline with ammonia, in which case the sodium sulphite may be omitted.

Be the development by the acid or alkaline method, if the film be merely edged with india-rubber, it frequently happens that the washing water gets beneath the film itself, causing what appears to be one big blister. A small cut in the collodion near one corner will allow all the water to drain out, and in drying there will be no trace of any imperfection due to this cause. The manipulations of fixing, drying, and varnishing are similar to those given for the same operations in wet plates.

DETAILS OF DRY PLATE PROCESSES WITH THE BATH.

THE GUM-GALLIC PROCESS.

THIS process was first introduced by Mr. R. Manners Gordon, and in his hands, and those of many photographers, has proved of great value. The negatives are possessed of remarkable delicacy, and have an appearance similar to wet plates.

To ordinary good collodion should be added a grain per ounce of cadmium bromide, and the plates kept in the bath for seven minutes in summer, and ten in winter, in order to convert the greater part of the bromide into the silver salt. They should be worked up and down in the solution till all greasiness has disappeared, and should then be left quiet till just before withdrawal.

After washing, the preservative is applied; it is made as follows:—

No. 1.—Gum-arabic	...	...	...	20 grains
Sugar-candy	...	...	...	5 "
Water	...	...	...	6 drachms.
No. 2.—Gallic acid	...	...	...	3 grains
Water	...	...	...	2 drachms.

No. 2 is prepared with the aid of heat, and is then mixed with No. 1 in the proportions indicated.

The gum-arabic should be that known as "picked;" that is, all yellowish lumps should be rejected, nothing but the white being used.

The water used should be distilled, rain or purified. If it contain iron in appreciable quantity, it is fatal to success.

To filter this solution, which contains gallic acid, great care should be taken to select a thin filtering paper which is free from iron. The presence of this impurity will be indicated by the solution turning an inky colour. The solution will be found to run through the paper better if kept warm.

A further aid to filtration will be given by the following contrivance, which, it may be noted, will serve to aid the filtration of most viscous bodies.

A cork or india-rubber stopper is pierced with two holes. Through one is passed a funnel containing a platinum foil support for the filter paper, and through the other a bent tube as shown in the sketch. By means of india-rubber tubing, this last can be connected with either an exhausting syringe, a Bunsen water-pump, or an aspirator of the usual form. The partial vacuum thus made causes the solution to pass with tolerable facility through the filter paper.



The preservative is applied by floating it on the surface for about one minute. The plate must then be allowed to drain, and finally be allowed to dry spontaneously in the drying-box. If the plate, previous to exposure, appear dull, it should be dried by artificial heat before being placed in the dark slide.

Exposures.—Great latitude in exposure is admissible; it should rarely be less than four times, nor more than twenty times, that which would be required for wet plates under ordinary circumstances; though with the strong alkaline developer (for which see page 66) the exposure may be reduced to that necessary for a wet plate. The development by this method is similar to that given at page 67. Some recommend its employment if the plate be kept for a long period (say a month) between exposure and development. The acid iron developer yields splendid negatives from a well-exposed and well-prepared plate (see page 65).

To develop the image, the backing (if any) must first be entirely removed with a damp rag, or peeled off in the case of paper backing. The plate should then be immersed in a dish of

water of not less than 65° Fahr. for two or three minutes, to soften the gum, and be finally rinsed under the tap. The developer should be now flowed over, and, if properly exposed, the image will begin to appear almost immediately. As it appears, more silver solution must be added, by two or three drops at a time, till the whole of the detail is visible. The film must next be well washed, and intensity gained by the ordinary pyrogallie acid intensifier and silver solution. The negative should have all the characteristics of a wet plate if properly manipulated. Should it be inferred that the plate is over-exposed, more of No. 1 may be added to the developer. It is important that the silver solution be added to the developer previous to flowing over the plate. If the latter be applied alone, and then silver be added, the resulting negative is liable to be granular in appearance.

THE COFFEE PROCESS.

There have been various modifications of this process; the best, as far as experience has taught, is that of M. de Constant. It is thoroughly reliable, and the plates prepared by this method keep well, and give soft negatives.

The collodion to be recommended for this process, according to M. de Constant, is ordinary collodion, with the addition of two grains of cadmium bromide to the ounce. If collodion be home-made, the pyroxyline should be manufactured at a high temperature in the acids (see page 58), and may be known in commerce by its yellow appearance, and by being found to separate in hard rather than in fibrous particles.

The plate is coated and the film sensitized, and washed in the ordinary way as described at page 59.

The preservative is formed as follows:—

No. 1.—Boiling distilled water	...	5½ ounces
(Mocha) coffee	... ..	½ ounce
White sugar	... ..	90 grains
No. 2.—Distilled water	... ..	5½ ounces
Gum-arabic	... ..	90 grains
Sugar-candy	... ..	20 „

No. 1 is allowed to cool in a well-corked bottle, and both solutions should then be filtered (see page 71), and mixed. It is

found convenient to pound the gum-arabic and sugar-candy in No. 2 before adding the distilled water.

The film may be coated with the preservative in the ordinary manner, two applications of a minute's duration being necessary. It is *better* to use a flat dish to *immerse* the plate in for two minutes, as evenness of coating is thereby insured. The plate should be then placed on end, upon folds of blotting-paper, to drain, previous to placing it in the drying-box.

The usual precautions for drying are to be observed in this as in the last process. When thoroughly dry, the surface of the film assumes great brilliancy, and exhibits neither stain nor fog by transmitted light. If a cloudy aspect show on portions of the film, a heated flat iron passed over it, an inch from the surface, will restore the brilliancy, and the plate will be fit for use.

M. de Constant stated that the exposure required for these plates was three times the length required for wet plates, under precisely similar circumstances. It is better to give six times the exposure, as the development is easily controlled in a slightly over-exposed picture. It is stated that comparatively longer exposure is requisite in bright sunshine than in cloudy weather.

The plates are very transparent, and there is a consequent tendency to blurring of the image. In such a case "backing" must be given.

Before development the plate should be covered with, or else immersed in, rain or good ordinary water for three or four minutes, and kept in motion. The water should then be drained off. For an $8\frac{1}{2}$ by $6\frac{1}{2}$ plate the following must be flooded over the plate :—

*Saturated solution of carbonate of ammonia...	8 drops
Water	4 drachms

This is worked over the plate till the image begins to appear, or till there is no further action caused by it, and it is then returned into the developing cup, in which must have been dropped from one to two drops of the following solution :—

Pyrogallic acid...	60 grains
Alcohol... ..	1 ounce

The ammoniacal water, with this solution added, should be swept over the plate in a manner similar to that employed in develop-

* One drop of concentrated liquor ammonia may be substituted.

ing a wet plate, as its action is extremely rapid. The image will now appear fully by reflected light, but be barely visible by transmitted light. The action of this solution must be continued till every possible detail in the shadows is brought out. The image may now be intensified by the ordinary pyrogallic intensifier (page 66); but by this method it will always appear transparent. To prevent this, M. de Constant recommended the following before the final pyrogallic intensification :—

Ammonio-sulphate of iron	...	...	45	grains
Copper sulphate	...	...	45	"
Citric acid	...	...	45	"
Water	...	...	3½	ounces

It will remain in good condition for a considerable length of time.

Two or three drops of a 20-grain solution of silver nitrate may be added to this after the first application. On the second application the negative becomes of a colour resembling that of a wet plate. The ordinary intensifier should be used after this. If the negative tend to become solarized (*i.e.*, to turn a reddish colour in the shadows), it should be fixed at once, and intensification take place afterwards.

The plates may be developed by I., II., IV., or V. formulæ given at pages 65 and 66.

Either sodium hyposulphite, or a weak solution of potassium cyanide, may be used for fixing the image. If the latter agent be used, a few drops of acetic acid should be dropped into it before application; this prevents blistering.

THE COLLODIO-ALBUMEN PROCESS.

The collodion should be very old and powdery. The dregs of different samples may all be thrown together, and though almost entirely insensitive for the wet process, it will be found to be no drawback for this; even collodion that sets opalescent is suitable. Mr. Mudd, whose exquisite landscapes are produced by this method, advises that it should contain no bromide; other workers do not insist on this condition.

The ordinary negative bath is used. The plate, being sensitized as usual, is washed thoroughly till all the free silver

nitrate is removed.* The plate is then flowed over with the following:—

Albumen	...	...	...	...	8 ounces
Ammonia	...	...	...	...	2 drachms
Potassium iodide	...	...	...	...	50 grains
Potassium bromide	...	...	...	...	10 "
Water	...	...	...	...	2½ ounces

This operation should be repeated twice, taking fresh solution every time. (The salts are first dissolved in the water, next the ammonia added, and then the solution mixed with the albumen. The whole is then beaten to a froth, and allowed to settle, and the clear liquid decanted or syphoned off for use. The eggs should be fresh, if possible. Before use, the solution should be filtered through a piece of sponge plugged into a funnel.)

The plate is next slightly drained, and set up to dry. At this stage it is quite insensitive to light if no bromide be present in the collodion, and will keep indefinitely. Before use, re-sensitizing must take place. A bath must be prepared made as follows:—

Silver nitrate	...	...	...	30 grains
Glacial acetic acid	...	...	...	½ drachm
Water	...	...	...	1 ounce

Into this the dried plate must be dipped, and be allowed to remain in it for at least one minute—ten minutes will not hurt it. After withdrawal it must be thoroughly washed, and then be set up to drain. When the excess of water has been absorbed, it is placed in the drying-box, and allowed to dry spontaneously.

Plates thus rendered sensitive will keep for a week in hot weather, but longer in cold.† The newer the plates the better will be the result. They will keep after exposure, which is of great advantage to the tourist.

The required exposure is long—in fact, it is almost impossible to over-expose; at least ten times the exposure of an ordinary

* It may be immersed in a five-grain solution of potassium iodide to secure this result.

† If a saturated solution of gallic acid be applied after the final washing, the plates will keep sensitive for months.

sensitive wet plate should be given, whilst twenty times would be better.

To develop, wash the plates thoroughly, and apply solution No. II., page 66.

After a few minutes the outline of the sky will appear by reflected, though nothing will be visible by transmitted, light. *Nearly* all the detail should be brought out, and but little to be done by the subsequent intensification. A considerable quantity of unaltered iodide should be visible in the image.

The density is brought up by pyrogallic and citric acid solutions belonging to the same formula (page 66).

During intensifying a slight deposit may take place on the surface of the film. This can be removed by carefully wiping it with a tuft of cotton wool. When of proper strength, the image should be fixed with sodium hyposulphite (see page 27).

An under-exposed picture may be forced up by using the plain pyrogallic solution warm, or of double or treble the strength given at page 65, or also by alkaline development as for the albumen-beer process (page 79).

The sky in the pictures produced by this process is rarely sufficiently opaque. Painting out must be adopted, an operation tedious, and often unsatisfactory.

ENGLAND'S COLLODIO-ALBUMEN PROCESS.

A very useful modification of the foregoing has been introduced by Mr. England. The plate is cleaned, sensitized, and thoroughly washed. It is then flowed over with diluted albumen. (The white of one egg to one ounce of water in cold weather, and two ounces of water in hot weather. These are well shaken up in a bottle till the albumen is thoroughly incorporated with the water, and the solution is filtered through sponge.) The plate is next rinsed to free it from superfluous albumen, and a silver solution (made similarly to the bath, acidified with acetic acid in the last process) is flowed over the film without any stoppage, and allowed to remain on it for a minute. It is then thoroughly washed, and allowed to dry spontaneously. The exposure is about the same as for a gum-gallic plate, and the development is conducted as for the collodio-albumen process.

HOT WATER PROCESS.

The last process may be varied by immersing the plate, immediately after it is floated with the preservative, in boiling water, to coagulate the albumen, and flowing over it a saturated solution of gallic in water, and setting up to dry. The development may be carried on as above, or by the alkaline method.

TANNIN PROCESS.

With this process bromo-iodized collodion ~~is~~ to be used. The plates require a substratum or an edging. After well sensitizing, they are thoroughly washed in distilled water, then under the tap, and finally rinsed with distilled water. The preservative—

Tannin (pure)	10 to 15 grains
Distilled water	1 ounce

is then flowed over them. (The addition of gum ten grains, and sugar five grains, is recommended by some, but the advantage is not very apparent).

The exposure required is about one and a half times that of a gum-gallic plate.

To develop a plate, it is first flooded with spirits of wine and water, then washed, and formulæ No. III. (page 66) used.

These plates are sometimes most satisfactory, at other times they are full of pinholes and stains. A good batch will keep well for two or three months.

This process may also be carried out by using a collodion containing nothing but bromide; the formula for which is—

Ether...	...	...	...	$\frac{1}{2}$ ounce
Alcohol	...	...	...	$\frac{1}{2}$ "
Pyroxyline	...	...	...	6 grains
Cadmium bromide	...	...	...	8 "

The plate coated with this collodion is immersed in a bath of the following—

Silver nitrate	...	...	...	80 grains
Water	...	...	...	1 ounce

No iodide need be added. The remaining operations are similar to those described above. Alkaline development, described for the coffee process, may be employed.

With a strong alkaline developer the exposure is shortened to that of a wet plate.

ALBUMEN BEER PROCESS.

The following process was introduced by the writer for solar photography, and was employed by the English Transit of Venus Expedition. It is, however, equally adapted for landscape work, and is very certain in its results. The collodion employed can be that described at page 11, though for more rapid work the following is better:—

Alcohol (·825)	...	...	4½ to 3 drachms
Ether	...	...	3½ to 5 „
Pyroxyline	...	...	7 grains
Ammonium iodide	...	...	2 „
Cadmium bromide	...	...	5 „

The relative proportions of ether and alcohol are adjusted according to the temperature in which the plates have to be prepared.

With the ordinary samples of collodion the usual 40-grain silver nitrate bath can be used, but with the collodion made as above it is advisable to use a bath made up to 60 grains, preparing it as given at page 16. In both cases rapidity is increased by the addition of ten grains of uranium nitrate. It has also been found advantageous to dip the plates in the weaker bath, at first allowing them to remain in it for a couple of minutes, and then to transfer them to the stronger for ten minutes more. This mode of procedure gives very sensitive and opaque films, the greater part of the actinic rays being thus utilized. The sensitiveness, however, greatly depends upon the porosity of the film, and every effort should be made to attain the maximum of this quality without injuring its texture. The addition of the largest practicable amount of water to the collodion tends to give this quality. After sensitizing, the plate is slightly washed, and then the first preservative applied, which is—

Albumen...	...	...	1 fluid ounce*
Water	...	...	1 ounce
Ammonia	...	...	1 drachm

This is beaten up into a froth (or is mixed by pounding it in a

* Dried albumen, 25 grains, may be substituted for the fluid ounce.

mortar with silica), and when settled the clear liquid is decanted off. This solution is mixed with equal quantities of any ordinary beer or stout immediately* before use, and is floated over the plate. (When bottled beer is used, it is advisable to drive off all the carbonic acid by a gentle heat.) The excess is drained off, and the film thoroughly washed under the tap for a couple of minutes, and is finally covered with a solution of plain beer, to every ounce of which two grains of pyrogallic acid have been added.

The plate is then dried in the ordinary manner.

The exposure, with well prepared dense plates, is at least as short as that necessary for wet plates, but great latitude is admissible. With twenty times the minimum exposure, a good negative can be obtained.

The development need not be effected for a month after exposure. The following solutions are required :—

No. 1.—Pyrogallic acid	...	...	...	12 grains
Water	...	...	...	1 ounce
No. 2.—Liquor ammonia (880)	...	...	...	1 part
Water	...	...	...	4 parts
No. 3.—Citric acid	...	...	...	60 grains
Acetic acid	...	...	...	30 minims
Water	...	...	...	1 ounce
No. 4.—Silver nitrate	...	...	...	20 grains
Water	...	...	...	1 ounce

The washing water before development should be of a temperature not less than 60° Fah. When washed as directed (page 59), the following developer is employed :—

To each half ounce of No. 1 are added three drops of No. 2, and, after well mixing with a stirring-rod, the solution is flowed over the plate.

Almost immediately the image begins to appear, and, after a few seconds' interval, the detail can be seen by reflected light to gradually develop. Another two drops of No. 2 are again added to the solution, which is once more flowed over the plate. Six drops of No. 3 are next dropped into the developing cup, and the solution from the plate poured on to it. Again the plate is

* This precaution is necessary, otherwise the tannin of the beer is precipitated by the albumen.

rinsed, this time by the acid solution, and intensification is given by the use of it with a few drops of No. 4. It is not advisable to allow too much detail to come out with the alkaline solution, but to allow a portion of it to be brought out by the subsequent treatment with the pyrogallie acid and silver. The alkaline developer reduces the bromide salt, and leaves the iodide to be attacked by the silver solution. It will be remarked that no restrainer such as bromide is employed; the albumen dissolved by the ammonia plays the part of a retarder, but not as a destroyer of the latent image.

When the image appears sufficiently dense, it is fixed by either sodium hyposulphite or by potassium cyanide.

A TEA PROCESS.

Of all dry processes, the tea process is the most charming, when exposure can be given to the plates within two or three days of preparation. They can be developed by the acid iron developer (page 65), or by the alkaline developer (page 66). They possess a beauty not obtainable by most processes.

The plate is coated with a bromo-iodized collodion, sensitized as usual, a preliminary coating or edging having been given to it. After thorough washing, it is *immersed* in an infusion of tea. This latter is prepared by pouring about ten ounces of boiling water on half an ounce of good black tea. After standing one or two hours it is filtered, and is ready for use. It will not bear the addition of either gum or sugar. The plates require about three times the exposure of wet plates, and should be developed within twenty-four hours afterwards.

DEFECTS IN DRY PLATE NEGATIVES WITH THE BATH.

Besides the defects that are common to both wet and dry plate processes, the following may be met with.

Blisters.—If blisters* make their appearance, it is probable, if the substratum be of albumen, that the solution is not sufficiently dilute. With some kinds of india-rubber blisters always appear.

Transparent markings may be caused by handling the plate with warm fingers before immersion in water previous to development. The corners of the plate alone should be touched.

* Warming the plate previous to coating with collodion is of service, preventing blisters.

Large opaque spots may be caused by allowing a warm finger to touch the plate during preparation or development.

A transparent edge will be caused by allowing the whole length of the edge of the plate to rest on blotting-paper when drying in the drying-box.

A lack of density is caused by the collodion being too thin, requiring more pyroxyline; by an insufficient quantity of bromide and iodide; by insufficient sensitizing in the bath; or by too weak an alkaline developer.

Lines may be caused by a stoppage in the wave of developing solution, by moving the plate in the drying-box previous to complete desiccation, or by an uneven flow of the preservative over the film.

Black spots on the film may be due to an india-rubber substratum, and to dust on the plate.

Transparent spots may be met with when photographing near the sea. They are probably due to the chloride of sodium which is held in suspension in the air. They rarely occur if the plate has been thoroughly dried by artificial heat a short time before exposure.

Pinholes may be caused by the solution of silver added to the developer dissolving out iodide from the film. If the preservative be not well filtered, such defect may likewise occur.

EMULSION PROCESSES.

THE dry plate processes which are now to be described differ from all others previously described, in that the sensitive salts are formed in the collodion itself by direct application of a solution of silver nitrate, and not by immersing a film in the solution. The principal sensitive salt is invariably the bromide, though it is frequently recommended to use chloride and iodide with it. An emulsion is formed readily with the chloride and bromide, but with iodide greater difficulty is experienced.

Though an emulsion in collodion is easy to be made, there are certain details to be attended to in order to secure success, and these depend upon a knowledge of the theoretical principles involved in the formation of the photograph and its subsequent development. For the purposes of this work it will suffice to

say that all soluble bromides are, to a certain extent, contaminated with impurities. It may be, to a small extent, inappreciable by ordinary tests, or it may be that they may be chemically demonstrated. In any case, it is necessary that these impurities should be left uncombined with silver, or that, if they are in combination, they should be in a state which shall have no effect upon influencing the deposition of silver during development. For a fuller account of the subject the reader is referred to "Emulsion Processes in Photography."* To eliminate the fog which is developed on uncorrected silver bromide emulsion, formed with an excess of silver nitrate, the addition of some mineral acid is necessary; or if it be "washed," as to be described presently, the addition of a weak alcoholic solution of iodine or bromine may be used. In the case of an emulsion prepared with an excess of soluble bromide—*i. e.*, one in which the soluble bromide is not wholly converted into the silver compound—no correction is necessary. Greater sensitiveness is secured by using an emulsion formed with excess of silver, and hence is generally adopted. The addition of silver chloride to an emulsion aids density, since it is more soluble than the bromide in the ammonia of the alkaline developer, and as fast as it is dissolved it is reduced to the metallic state and deposited on the image.

It will be simplest to describe an ordinary emulsion process first, and then to take into consideration a washed emulsion process. A washed emulsion will keep indefinitely, and remain at a standard sensitiveness, and hence is useful in preparing plates with a preservative.

UNWASHED EMULSION PROCESS (CANON BEECHEY'S).

The first process to be described will be Canon Beechey's, as it is very simple and most efficient. The following is the *modus operandi* :—

Take cadmium bromide (anhydrous)... 400 grains
Alcohol (.805) 10 ounces

and allow the mixture to stand. Decant carefully, and add eighty minims of strong hydrochloric acid.

Take of the above solution ... $\frac{1}{2}$ ounce
Absolute ether (.720) 9 drachms
Pyroxyline (as above) ... 10 to 12 grains

* Piper and Carter, Gough Square.

To sensitize this, dissolve forty grains of silver nitrate in one ounce of alcohol (.820 sp. gr.) The best method to effect this is to pound up the silver nitrate in an agate mortar, and take only a quarter of the alcohol and boil it in a test tube containing the silver salt. The alcohol will become slightly brown (due, probably, to the formation of a fulminate of silver), and should be decanted off into the bottle containing the collodion. The remaining silver should be dissolved up in a similar manner, the ounce of alcohol being just sufficient to effect solution. Between each addition of the silver nitrate the collodion should be well shaken. When the final addition is made the emulsion should be very smooth and rather thick. When poured upon a strip of glass plate it will appear transparent by transmitted light; but after keeping twenty-four hours (occasionally shaking the bottle containing it in the interval) it ought to be very opaque and creamy.

The plate having been coated with a substratum or edged, the collodion (which should have been shaken about half-an-hour* before it is to be used) is poured on it in the ordinary manner, and, when set, immersed in a dish of distilled or rain water. When all greasiness has disappeared it is flooded with any of the preservatives already mentioned. Canon Beechey recommends the plate to be immersed in a dish containing beer to which one grain per ounce of pyrogallie acid has been added. The drying is conducted in the usual manner. The exposure may be taken to be about the same as that necessary to be given to a gum-gallic film. Between exposure and development the plates will keep fairly for a week, but after that seem to lose detail, and appear under-exposed. The alkaline developer IV and V. (page 66), is used for developing these plates, and the instructions given should be minutely followed.

Should the preservative on the plate be soluble in alcohol, then that solvent should first be applied to the plate (edged round with india-rubber if necessary), and then be washed till all the alcohol has been removed. It is very convenient to develop these plates on a levelling stand, in which case an india-rubber edging given to the film is a great help to keeping the solution on the plates.

Sufficient intensity is not always gained by alkaline development, but the plates also may be developed with the ferrous-

* Canon Beechey recommends the bottle to be shaken immediately before use, and the emulsion filtered.

oxalate developer (page 68), by which a greater density can often be obtained. If still deficient, the ordinary intensifier (page 66) should be applied afterwards. It is not always easy to secure sufficient density with emulsion plates, even by the application of silver and pyrogallic acid. In this case, after fixing, the image may be converted into iodide of silver by the iodine solution (page 23), be washed, flooded with a weak solution of silver, be exposed momentarily to light, and be then intensified by iron or pyrogallic acid (page 66).

It should be noted that a film to which an albumen or gelatine preservative has been applied is very difficult to develop by any iron salt, and the writer never attempts this mode of development on plates so prepared.

The plates are fixed with cyanide or hyposulphite (see page 27).

WASHED EMULSION PROCESS.

WHEN to a soluble bromide in collodion silver nitrate has been added, and an emulsion of silver bromide formed, there remains, as the result of the reaction, nitrates held in solution, or perhaps in minute suspension. If the emulsified collodion were applied to a plate, and allowed to dry in this state, there would be a crystallization of these nitrates, and unless they were removed the film would be in an unsatisfactory state for developing the image. Washing the film, of course, effects this; but it is more convenient to wash the emulsion itself.

The following will be found a good sample of a washed emulsion process.

The plain collodion is made as follows :—

Alcohol	...	...	...	...	...	2½ ounces
Ether	...	...	...	...	...	5 "
Pyroxyline (prepared as given at page 6)						90 grains

It is proposed that eventually 200 grains of zinc bromide shall be dissolved in the collodion, or combined with silver nitrate in excess.

Two portions of 100 grains each are weighed out: one is dissolved in the smallest quantity possible of alcohol, and 4 or 5 drops of concentrated nitric acid are added to it to get rid of any oxide or other impurity that may be present. This is then

added to the collodion. The other 100 grains are similarly dissolved, but a larger proportion of nitric acid added, viz., 10 drops. This is kept in a test-tube ready for use. We next require 300 grains of silver nitrate to saturate the zinc-bromide, and to allow 3 grains in excess for each ounce of the concentrated collodion. As this will probably be about 11 ounces by the time the additions are made, 330 grains of silver nitrate (which has previously been pounded up in an agate mortar, or the crystals of which have been crushed with a glass stopper on a thick glass plate) are weighed out. This amount is then placed in a large test-tube, with 5 dr. of water, and warmed : a perfect solution ought to result. Ten drops of nitric acid are next added to it. In another test-tube $1\frac{1}{2}$ oz. of alcohol ($\cdot 820$ to $\cdot 830$) are boiled and poured upon the dissolved silver. The two fluids may not mix at first, but by pouring them from one test-tube to another this is readily accomplished. The collodion is now placed in a glass jar, and a stirring rod placed ready to hand. It is usually insisted that the subsequent operations should be conducted in the dark room. This exclusion of light is quite unnecessary (as the writer has practically proved), owing to the presence of the nitric acid, which renders the sub-bromide inert as fast as it is formed by the action of light. The test-tube containing the silver is now taken in the left hand, and the stirring rod in the right, and three-quarters of the silver nitrate solution is poured, drop by drop, into the collodion, which is kept in brisk agitation by the glass rod. The silver solution is then placed on one side, and the dissolved bromide solution taken in the left hand. All the latter is now added drop by drop, and then the remainder of the silver solution in a similar manner. Some of the silver salt is sure to be found crystallized on the edge and sides of the test-tube. This is re-dissolved, as before, in a little water and half-an-ounce of alcohol, and added with the same precautions. If the above details have been carefully carried out, the colour of a candle or gas-flame, when viewed through the liquid which runs down the inside of the glass jar after agitation, should appear of a deep orange approaching to a ruby tint. When in this condition, it may be judged that it has been rightly prepared. With the glass rod a drop or two of the emulsion should be dropped on to small strips of glass, and examined by daylight for structure, &c. When viewed through a window, the principal part of the light transmitted should be orange. A little potassium *chromate* should be dropped on to the emulsion on the

plate, and a bright red colour will show that the silver is in excess, which is what is required in our case. If this colouration be absent, it will indicate that the soluble bromide is in excess, which, in some modifications of the same process, is what may be desired. The emulsion must next be decanted off into a bottle capable of containing at least double the amount of fluid—that is, at least 20 ounces—and it should then be shaken for ten minutes. It may now be put on one side for from sixteen to twenty-four hours, when it will be ready for the next operation.

For other methods of mixing the silver and the soluble bromide, the reader is referred to “Emulsion Processes in Photography,” page 34.

Evaporating the Solvents.—An emulsion generally may be prepared in the afternoon of one day, well shaken before leaving the laboratory, and on the next day, about noon, the emulsion will be ready for drying. The mode adopted by the writer is as follows:—The emulsion is poured out into a flat dish, to a depth of a quarter of an inch, and placed in a dark room, the temperature of the latter being raised, if possible, to 70°. For the ten ounces of emulsion made, a porcelain dish about 14 by 12, by three-quarters of an inch deep, is required.

After a short interval it will be found that a skin forms on the surface of the collodion; this is broken up with a glass rod, and a fresh liquid surface given to it. Every half hour the whole of the emulsion is thoroughly well stirred up, till it begins to break into lumps, when it can be left a short time, for the solvents still further to evaporate. It is ready for the first washing when the lumps require a little force to break them up—in other words, when they are about the same consistency as a collodion film before dipping into the bath. The mass is then removed to a glass beaker, and covered with distilled water. At this point we have a good test as to whether the evaporation of the solvents has been continued far enough. If only a few of the lumps rise to the surface, the evaporation has been sufficient; if, on the other hand, the majority float on the surface of the water, it has not been continued long enough. The reason of this tendency of the lumps to rise to the surface is due to the light specific gravity of the ether and alcohol, which, even with the weight of the solid matter, is not sufficient to counter-balance the specific gravity of the water.

The foregoing is the simplest, but rather wasteful, method,

and resort may be had to a still* by which to evaporate and collect the solvents, but in this case the nitric acid must be omitted, and the elimination of fog-producing products take place in the first wash water by the addition of nitric acid.

For the above quantity of emulsion, 1 dr. of nitric acid, which will be ample to secure freedom from fog, should be added to the wash water. After a couple of hours the true washing may commence.

The emulsion may be placed in a jar or jam pot, and be covered with water where it can stand two or three hours in the dark without detriment, when it should be changed. The way in which the washing can be economically effected, as regards time, is as follows:—A piece of coarse calico which has previously been washed in carbonate of soda, and then well rinsed and dried, is spread over the top of a second glass jar or large jam pot, and the contents of the first thrown on to it. The calico acts as a strainer, and the solid pellicle is left on it. The calico is next taken up by the sides, and the contents are twisted up in it, and as much as possible of the liquid then wrung out. The calico is untwisted, and a bag formed (by tying up the ends) to hold the emulsion, which is shaken up and immersed in fresh distilled water. After a quarter of an hour the wringing operations are again proceeded with, and this process repeated three or four times. The expelled water should now be tested for free silver nitrate by a drop of hydrochloric acid. If it give more than a slight milkiess, such as is produced by adding silver nitrate to water containing a grain of common salt to the gallon, it must be washed till this maximum is attained.

Preparing the Pellicle for Re-emulsifying.—A very important part of emulsion making is now to be touched upon, viz., getting rid of the water held in the pellicular mass.

To commence with, as much water as possible should be squeezed out, and then we may proceed in one of these ways.

1st. We may lay it out flat on a piece of blotting-paper, and allow it to dry spontaneously. 2nd. We may put it in a flat porcelain dish, and place it in a water bath, the temperature of which can never exceed 212° , and thus all moisture may be got rid of. In this proceeding, the very greatest care is necessary, as the emulsion is apt to become very hard indeed, so much so as to be scarcely soluble; in addition to which, it is often apt to

* See "Emulsion Processes in Photography," page 33.

blacken spontaneously. The third method is one which we can confidently recommend for washed emulsion, being very simple, and absolutely improving its qualities when redissolved. This is simply to cover it with rectified spirit ($\cdot 820$) after as much water as possible has been squeezed out. In an hour's time the excess is drained off, and the pellicle is squeezed in the cotton rag as before. It is then once more covered with the spirit, and left for half an hour, when, after draining away the superfluous spirit, it is ready for re-emulsifying. If it be desired to keep the pellicle in a solid state, it will only be necessary to expose it to the air for a few hours, when it will be found quite dry.

It is instructive to examine the washings from the spirit. It will be found that there is a certain small quantity of silver bromide in suspension, which can be filtered out. If the spirit be distilled over, a semi-opaque liquid residue will be left, having a very high boiling point, a strong and disagreeable smell, and containing some organic salt of silver, which discolours in the light. It may be said that this organic compound is necessary for density of image, but a trial of the emulsion washed in this way will prove the contrary, in addition to which it will be found much freer from spots than that washed and dried by the first two methods indicated above.

There are some pyroxylines which it would be dangerous to treat in this manner, since they are soluble, to a certain extent, in absolute alcohol; but it seems to the writer that any such pyroxylines are detrimental when washed collodio-bromide emulsion is in question. If they are employed, the first or second method must be adopted.

The dried (or moist with alcohol) pellicle has next to be dissolved in its proper proportions of solvents, which are about 6 grains of pyroxyline to every ounce of the two when mixed. It is better to make it up first to the strength of 9 grains of pyroxyline, and then to add the remaining solvents, since the colour of the emulsion seems to be better when a greater degree of viscosity is present when the pellicle begins dissolving. In two or three hours the whole of the silver bromide should be in suspension. It will be found, however, that there is an improvement in the quality of the film after the lapse of a couple of days, or even more. A plate should be tried before diluting down the collodion with more ether and alcohol, in order to test its flowing qualities, and to note the opacity of the film.

In our own experience we like a plate through which, when

freshly coated, the light from a gas jet can be seen, but which, when dried, is perfectly opaque. In this condition the film is tough, requires no backing, and is always capable of giving sufficient density by alkaline development alone.

The plate can now be simply coated with the emulsion, and when dried is ready for use. As the result of hundreds of experiments, the writer has unwillingly come to the conclusion that a washed emulsion without a preservative of some kind is a dangerous process in which to place absolute trust. Films which would give perfect negatives, free from those spots which refuse to develop, may, after keeping some time, show them in perfection, spoiling every picture taken upon them.

The reader may turn back to dry plate processes with the bath, and employ any of the preservatives there mentioned. The following is one recommended by Colonel Stuart Wortley:—

No. 1.—Salicine, enough to make a saturated solution in distilled water.

No. 2.—Tannin	...	...	...	60 grains
Distilled water	...	...	...	1 ounce

No. 3.—Gallic acid	...	...	...	48 grains
Alcohol	...	...	...	1 ounce.

To make the preservative, take of—

No. 1	...	...	...	2 ounces
No. 2	...	...	..	1 ounce
No. 3	...	...	...	$\frac{1}{2}$ "
Sugar	...	...	...	40 grains
Water	...	...	...	7 ounces.

This preservative may be used over and over again with occasional filtering. The plates are best immersed in it.

A substratum will in many cases be required, though often by first washing off the preservative, then allowing the film to dry, and flooding with alcohol, and again washing, and then proceeding to development by the alkaline or ferrous-oxalate developers (pages 66 and 67), any tendency to blister, or unequal development of the image, will be prevented. Those who have not the time to adopt this method must use the substratum, an edging being of but little use, and unless the preservative be soluble in alcohol.

THE GELATINO-BROMIDE PROCESS.

In the following processes we have gelatine instead of collodion as the vehicle in which the sensitive salts are held. The plates are usually extremely rapid. In Mr. Kennett's published process we have the first of the kind which became practically useful. The following is the method of preparing the gelatine emulsion according to his plan.

Forty grains of Nelson's photographic gelatine are soaked in water till thoroughly swelled, and then drained. Thirty grains of potassium bromide are next dissolved in eight drachms of water, and poured upon the swollen gelatine. The jar containing it is next placed in a can of hot water till the gelatine dissolves and a perfect mixture is obtained. Forty grains of silver nitrate are next dissolved in eight drachms of water, and poured into the gelatine mixture little by little, stirring with a rod the whole time (see page 86). The emulsion is next poured into a flat dish, and allowed to set thoroughly, and is then broken up into little lumps and covered with water, and allowed to stand for an hour, when the water is changed, and the washing is continued for four or five hours. The wash water is tested for free potassium bromide by taking a portion of it in a test-tube, and adding a drop of silver nitrate solution to it; if present, the washing is continued till a drop of silver nitrate causes no milkiness. After thoroughly draining, the gelatine is dissolved by placing the vessel containing it in a jar of hot water, and the whole amount is, after adding one drachm of alcohol, made up to two ounces of solution.

Captain Roger Laurent has proposed a plan of keeping gelatine emulsion from decomposing by immersing the bottle neck downwards in a vessel containing very dilute carbolic acid.

There are other methods of freeing the gelatine from soluble salts which have been tried, the first of which was introduced by Mr. King. He dialized his emulsion in the usual way, as practised by chemists. This method, though scientific, is tedious, and we hardly think that emulsion makers who try the other plans will adopt it. The other methods which we give are due to the firm of Wratten and Wainwright, and both are very easy of application, and perfectly successful. Their first plan is as follows:—The emulsion being made up as described above, and after being allowed to rest for two or three hours, two ounces of alcohol (to each ounce of water used) are poured into the bottle

containing it, and well shaken up. The gelatine rapidly assumes a pasty appearance, and subsides to the bottom. The bottle is then inverted, and the fluid, which contains the soluble nitrates and excess of water, is poured off and preserved for distillation. The explanation of the efficacy of this method is, that the alcohol has a greater affinity for water than has the gelatine, and that in extracting the water the soluble salts are extracted with it. Methylated spirit not containing gum may be used, and the lower the specific gravity the more effectual it is.

The emulsion thus freed from soluble salts may be treated with warm water, to cause it to redissolve, or it may be dried to the state of pellicle.

The second method, due to Messrs. Wratten and Wainwright, consists in squeezing the set gelatine emulsion through napless canvas (such as is used for ladies' Berlin wool work) into water. The threads of gelatine are collected on a tray, and the water filtered off through a calico bag.

We recommend that this operation be repeated a second time, using, it is almost needless to say, a fresh amount of wash-water.

Instead of this second squeeze through the canvas, the calico bag may be tied at the neck, and, with the gelatine in it, immersed in distilled water for ten to twenty minutes, when the salts will be found to be extracted. The gelatine is next scraped off the bag, and redissolved by heat.

To prepare the dry plate, the glass is first thoroughly cleaned and slightly warmed, just so much as to be pleasant to the soft part of the hand. When preparing a number of plates, the writer recommends that some large size thick glass plates be procured, and accurately levelled by a spirit-level, the horizontal position of each being obtained by three little wedges placed beneath its edge. The warmed plate is next taken on a pneumatic plate-holder, and some of the gelatine solution, filtered through fine cambric into a glass measure in such a way as to avoid bubbles (or by stretching the cambric across the lip and a portion of the top of a measure), is poured in a circular pool in the centre of the plate, and gradually made to flow to the edges. If occasion require it, the liquid may be spread by a glass rod. The surplus gelatine is now poured back into the measure, leaving sufficient of the solution on the plate, which is about three times the quantity that would be left by thorough draining. The plate is next placed on one of the levelled larger glass plates, and allowed to set. When well set, it may be removed to a tolerably level

shelf, and allowed to lose moisture spontaneously. When the films have lost half their water, if possible a current of warm air should be passed over them to increase the rapidity of total desiccation. The drying box, or the contrivance mentioned at page 61, will answer, provided the temperature at no time exceed 100° F.

The proper equivalent of ammonium bromide may be substituted for the potassium bromide (*i.e.*, 98 grains of the former for 119 grains of the latter) in forming the emulsion; and it may also be prepared with an excess of silver nitrate. A slight excess is safest, forty-six grains being substituted for the forty grains above; but, on the whole, the excess of bromide gives most reliable plates, since the addition of acid is almost inadmissible, and there must be a liability to fog from the cause stated in the first part of this work.

It has been proposed to substitute for half the amount of water used in dissolving the gelatine the same quantity of mild ale, or of a coffee solution, but we doubt whether it has any advantages, and the simplest process just given is recommended for good ordinary plates.

Mr. Kennett has simplified the manipulations for dry plate makers by drying the gelatine emulsion after washing, and issuing it in the form of a pellicle. The mode of drying he has patented. To form an emulsion from the pellicle, fifty grains of the latter are dissolved in one ounce of water by aid of heat. After soaking for a quarter of an hour, and filtering through muslin, the emulsion is ready for use.

The exposure is about equivalent to that necessary for wet plates.

For developing these plates the following solutions are required:—

1.—Pyrogallic acid	...	...	...	4 grains
Water ...	...	...	...	1 ounce
2.—Ammonia (.880)	...	...	...	$\frac{1}{2}$ ounce
Water ...	...	...	...	8 ounces
3.—Potassium bromide	...	...	...	180 grains
Water ...	...	...	...	8 ounces

The plate is placed in a dish, in which enough of No. 1 is placed to cover it. After a few seconds, the solution is poured

into the developing cup, and to every thirty parts of No. 1 used, two parts of Nos. 2 and 3 are added. The mixed solutions are poured on the plate in the dish, and two or three drops of No. 2 are added to give density.

In case density be deficient, Mr. Kennett recommends :—

Pyrogallie acid	...	...	...	3 grains
Acetic acid	...	...	...	6 drops
Citric acid	...	...	...	1 grain
Water...	...	...	...	1 ounce

This is flowed over the plate, and then two or three drops of a twenty-grain solution of silver nitrate are dropped into the cup; the solution is then poured back on to the plate, and density will be rapidly obtained.

The colour of the negatives is usually of an olive colour, and very non-actinic, hence care must be taken not to push the density too far.

The preparation and development of the plate should take place in any subdued light, as they are extremely sensitive to weak radiations. Blisters and frilling, of the edges sometimes make their appearance. Hard water containing sulphates are said to obviate this evil, and it has been proposed to soak the plates in a solution of Epsom salts as a deterrent.

RAPID GELATINO-BROMIDE PROCESS.

Mr. Bennett has recently described a method of preparing plates by which extreme rapidity is secured. The following description of it is extracted from the *British Journal of Photography*, as he describes it, as much stress is laid on following strictly the directions laid down. The writer has worked the process from the description given. Mr. Bennett says :—

“First, then, the light. I have tried ‘warranted non-actinic,’ and ‘tested by spectrum analysis’ glass, and can print transparencies through two thicknesses of such in about thirty minutes. Procure, therefore, from a glass merchant, some of the *darkest* shade of ruby, and use two thicknesses for daylight and one for lantern. This is positively necessary, as we are to use a very powerful developer upon a very sensitive plate. If gelatine workers were careful on this point I think we should hear less of ‘organifiers’ or ‘want of density’ than at present. I never have any trouble on that score, because, no actinic light

having touched the emulsion, I can apply any amount of development without any danger of fog.

"To make 'assurance doubly sure,' use a ruby-coloured hock bottle, and with two eight-ounce decanter-shaped bottles made of test-tube glass to stand heat—procurable at Rouch's, and, doubtless, elsewhere—weigh out for a ten-ounce solution—

Ammonium bromide	70 grains
Best silver nitrate	110 "
Gelatine	200 "
Distilled water	6 ounces

Use Nelson's 'No. 1, photographic gelatine,' for with the opaque sixpenny packets you have irregularity, red fog, and frilling. Place aside four ounces of water for the bromide, and two ounces for the silver; dissolve the bromide with heat in one of the test-bottles in one or one and a-half ounces of water; pour into the hock bottle; swill out the test-tube with the remainder of the four ounces set aside for the bromide, and also pour in. I do it by heat to ensure all being dissolved, as it does so very slowly after the gelatine is inserted. The four ounces of solution being now almost cold, add the gelatine, shake up well, and place in two or three gallons of water at 90°. I use a fish kettle with lid. [A good-sized saucepan with a lid answered perfectly with the writer.] In two hours the bromized gelatine will, after well shaking, be quite liquid, and also nearly at 90°. Now dissolve the silver in the other test bottle by heat in one ounce of water, cool to 90°, and pour in; use the remainder of the two ounces set aside for the silver to swill out, heat to 90°, and pour in. By being so particular we get regularity, and are able to mix the plates of different batches, which is a great boon. Shake the emulsion very briskly, and replace in the kettle for two, four, or seven days, according to rapidity required. The temperature should never be over 90°; if you do not let it exceed that you will not have red fog. 'Cosy' it up with flannel, and it will not lower many degrees during the night. I, however, use a stove two feet across, and place it on that; a faint gas jet below keeps it always at 90°. I shake up every twelve hours. If washed in two days, the emulsion is rapid and dense; in four days, more rapid and less dense—quick enough for any drop shutter known, when developed as below. With some that I kept for seven days, with drop-shutter, on a dull February morning, pebbles close to the camera were perfectly exposed. The negative was thin under ammonia, but bore intensifying to any extent.

"Cool the emulsion in a bottle not smaller than a Winchester quart, and wrap it up in brown paper to exclude all light except the lip of the neck. Let an india-rubber tube go quite to the bottom of the bottle to stir away those layers of water which, on account of greater specific gravity (by reason of the salts they now contain) would otherwise remain there. Wash for twelve hours; a dribble is sufficient. Upon melting you have eight or nine ounces of emulsion; add three-quarters of an ounce of pure alcohol heated to 90° ; fill up with water (also warm) to ten ounces, and coat (see page 91). The plates should be only lukewarm, or you will have red fog. For beginners it much helps the coating to double the quantity of alcohol, leaving out water to that extent. The operator should not be alarmed at the peculiar mottling of the film (due to the alcohol) directly after coating; this subsides in a few seconds to an even surface. The extra alcohol does not appear to alter the sensitiveness, and is a great help; but with experienced workers it is not necessary, and the quantity mentioned is sufficient to draw the emulsion up to the edges, which is the sole object of introducing it. When no alcohol is used you always have *thin* edges, which is very objectionable, as the negative, of course, will print dark at those parts, and this small addition of alcohol totally rectifies this fault. It is difficult to measure the exact quantity of emulsion required for each plate; one ounce would probably cover *eight* plates of $6\frac{1}{2}$ by $4\frac{3}{4}$ size.

"By darkening a good-sized room temporarily for coating, it obviates the necessity of a drying box, for if the films can lie on the table for twelve hours they will be dry, or sufficiently so to stack up in an ordinary box. Expose a few plates with small stops—instantaneously; gradually increase the size of stop or length of time.

"To develop I use, for $6\frac{1}{2}$ by $4\frac{3}{4}$, one ebonite tray $8\frac{1}{2}$ by $6\frac{1}{2}$ for ammonia, one ditto for silver, and one 10 by 8 to cover over either during development to keep all light off. After soaking a minute, pour the following quickly along that side of the tray which is not occupied by the plate, and by rocking the dish suddenly send it sweeping over the plate (it is developed in five to twenty seconds):—

Pyrogalllic acid	...	...	...	1 grain
Bromide	...	...	...	none
Pure undiluted liquid ammonia	...	...	...	1 to 10 drops
Water	...	...	...	1 ounce

Do not flood with pyrogallic acid first, or you will render the plate slower; nor add more pyro, or you will again slow the plate, and, moreover, have it too dense. If the exposure has been sufficiently short, you should have a dense negative, with bare glass for shadows, almost as soon as the developer has covered it. A 10 by 8 Dallmeyer triplet, with drop-shutter, would require in good light (say) four drops of ammonia; if bad light, eight to ten drops. A six-inch single lens, in good light would require (say) one drop; in bad light, four drops. If much ammonia be used, and the plate be not developed in half a minute, make fresh developer, and wash the plate.

"Being now in possession of some extra-sensitive plates, put one in a thick book, and, having placed it five or six inches from your ruby glass window or lantern, draw out the plate one-third for a few minutes; again draw it out further one-third more for a short period. You will then have the film in three divisions, as it were—one portion not having been exposed to the red light, and the other two portions having had different exposures. Now develop, and use (say) three drops of ammonia. If your light be still at fault, the exposed portions of the plate will fog; in that case, use another thickness of ruby glass."

PAPER NEGATIVE PROCESSES.

The following is a modification of the original calotype process, which has yielded excellent results in many hands. It is therefore given in detail. Large pictures may be produced by it which can *very nearly* bear comparison with those produced with wet plate negatives. Calotype is convenient, owing to the small weight that it is necessary to carry.

BUCKLE'S PROCESS.

The following process is the best of a variety:—

No. 1.—Silver nitrate	...	...	35 grains
Distilled or purified water			$\frac{1}{2}$ ounce
No. 2.—Potassium iodide	...	...	35 grains
Distilled water	...	...	$\frac{1}{2}$ ounce

Mix these two solutions,* and a precipitate will be formed, and

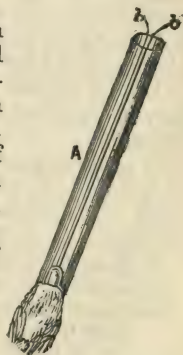
* The potassium iodide solution should invariably be poured on the silver nitrate solution.

if the above proportions of water be maintained the precipitate will retain a more solid and condensed nature, separating itself more readily from the supernatant fluid than would be the case if smaller amounts were used. The deposit of silver iodide should be washed in small portions of water (one ounce to each washing being sufficient), as large quantities render the deposit too fine. The method of washing is as follows. The supernatant fluid should be carefully decanted from the iodide, the fresh water should next be added, and the deposit briskly stirred in it with a glass rod. When well settled the water should be decanted. The operation of washing should be repeated three or four times.

The iodide must now be redissolved by a solution of potassium iodide in two ounces of water. The best way of effecting this is to place the precipitated silver iodide in a two-ounce measure with the two ounces of water and six drachms of potassium iodide. This will not effect the solution of the silver iodide, but extra crystals of the potassium salt should be added till it is complete—that is, till the liquid is just *not* clear, or in a semi-transparent state. Should this solution of iodide of silver be too powerful and too thick when coating the paper (which is shown by a deep sulphur-colour instead of pale primrose on the paper), $2\frac{1}{2}$ ounces of water may be used instead of the 2 ounces.

The paper to be used should be as tough and grainless as possible. Turner's paper was the best suited for the process, but at present it is not procurable. Good English made paper of the consistency of medium Saxe answers as a substitute.

Cut the sheet of paper into convenient sizes, and pin it by its corners on to a flat smooth board. Apply the solution with a cotton wool brush evenly and plentifully. The accompanying figure shows a cotton wool brush which answers well for the purpose required. A glass tube, A, is cut off from a length of $\frac{1}{4}$ -inch soft glass tubing, by filing round it with a file at about 4 inches from one end. A slight jerk will break off this piece, and the ends are slightly heated in a flame to take off the sharp edges. A loop of string, *b*, is passed down the tube, and cotton wool inserted in the loop. The ends are then pulled, and the loop carries a portion of wool into the tube, the greater part remaining outside to form the brush.



The paper must be allowed to dry partially. Next wash the sheet in rain or distilled water, taking care to dispel all air-bubbles, and, having agitated it, leave it in the water whilst a second sheet is coated. When this second sheet is ready for immersion, withdraw the first sheet from the pan and place it in a second dish (likewise containing rain or distilled water), and place the second sheet in the first pan, and so on. When well washed in the second pan the paper ought to assume a bright uniform yellow colour, tending to green. The washing will take from one to two hours. Pour off the water and rinse two or three times, drain, and hang the sheets up by one corner to dry.

The paper in this state is nearly insensitive to light, and can be kept between leaves of a book or blotting-paper.

To render sensitive, pin the paper to a board in the dark room, as before described, having previously prepared—

No. 1.—Silver nitrate	...	...	50 grains
Distilled water	...	...	1 ounce
Glacial acetic acid	...	...	80 minims

No. 2.—*Saturated solution of gallic acid in distilled water.

Take six drops of No. 1, add to it six drachms of distilled water, next six drops of No. 2, and finally add from one to three drachms† of distilled water again. The mixture should then be well stirred with a glass rod. Apply this solution lightly, but plentifully, with the cotton brush to the iodised paper, blot off the sheets in succession, and place two back to back with blotting-paper between them.

In very hot climates, twelve drops of No. 1 and seven of No. 2 may be substituted with advantage for the proportions given above.

A plate of glass of the size of the inside of the camera slide, and having the thickness necessary to bring its surface to a level with the top of the supporting silver wires, having been selected,

* A stock bottle of gallic acid may be kept, filling up with water, and shaking well after any of the solution is taken out. If all air be excluded from the bottle, it will not turn brown or discolour.

† Heat quickly decomposes a strong solution of Nos. 1 and 2, consequently the greater the heat, the larger should be the quantity of water added. This method of mixing also prevents the instantaneous decomposition of the solution.

the corners are broken off. The glass should then be placed in the frame; the back surface of it will now be on a level with the inside of the silver wires. On this plate place the sensitized paper, and back it with another glass plate. When in the camera, the paper will coincide with the front of the ground glass. By attaching the corners of the paper by gum to one glass plate the use of the second may be avoided.

For a fifteen-inch focal distance single landscape lens, full aperture, three minutes in bright light will suffice. This may give some sort of a guide for exposure with other lenses.

To develop the image, take the paper out of the dark slide, and pin it on the board as before. Apply equal parts of Nos. 1 and 2, with equal quantities of water, with the brush, and allow the developing action to proceed until it begins to flag. Next apply the solution of gallic acid *very* slightly until the deep shadows begin to dim by transmitted light. The development must then stop, otherwise fog will ensue. The development is easily arrested by placing the paper face downwards in water, and using three or four changes, allowing a quarter to half an hour between each change. If, on opening the dark slide, the image on the paper appear perfectly defined, and of a dirty red tint, it is a sign that the exposure has been too long. In this case use one part of No. 1 to two parts of No. 2. Should under-exposure be suspected, two parts No. 1 to one part of No. 2 should be the proportions employed. On foliage or dark shadows which do not develop readily, these last proportions of Nos. 1 and 2 should be applied, but the brush should, almost immediately afterwards, be dipped in the solution containing the ordinary proportions, and be passed over the whole of the picture, to equalize the development, and to prevent marks arising from the use of the different strengths of developing solution.

The negative is fixed by immersing the developed picture in

Sodium hyposulphite	...	...	2 ounces
Water...	...	...	32 "

The fixing is complete when all the yellow of the iodide has disappeared. This will usually take about half an hour. The paper negative must be washed for two or three hours in running, or frequent changes of, water, and dried spontaneously.

The negative, when dried, is ready for waxing. A flat iron should be warmed, and a small cake of pure white wax be brought in contact with its point on the back of the negative.

The heat melts a certain amount of the wax, which, by moving the iron, can be spread over any desired portion of the picture. Blotting-paper should be then placed over the negative, and the hot iron passed over the surface of the blotting-paper till all superfluous wax is removed. The negative is now fit for printing purposes.

It is usual to wax the whole of the negative, with the exception of the sky. Unless the sky be very dense, any portion of it that has been waxed will have to be rendered opaque with indian-ink or its equivalent.

Sensitized calotype paper will only keep two or three days. The quicker it be employed after sensitizing the better will be the result. The paper which has been coated with iodide, but not sensitized, will keep for an indefinite period if protected from light.

GREENLAW'S PROCESS.*

First examine and select thin negative paper, and reject all that show any irregularities, holes, patches of unequal density, &c.; that recommended for Buckle's process will answer.

Make a solution of—

Potassium iodide ...	...	...	1,000 grains
Potassium bromide...	...	...	300 „

(For much foliage the latter may be increased to 450 grains).

Distilled water	40 ounces
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and add enough of pure iodine to give the solution a dark claret colour. Then filter.

Into this place as many sheets of paper as you can with ease, being careful that no air-bubbles exist. Allow the paper so immersed to rest for an hour; then turn the whole upside down, and hang the sheets up to dry, taking off the last drops with white blotting-paper. This may be done in diffused light. When dry, place sheet over sheet evenly in a portfolio in which no other papers, except blotting-paper, are placed. They will then be iodized a dark purple, which will keep any time. They, however, turn a light brown colour. Be sure, in working, that

* Taken from the YEAR-BOOK OF PHOTOGRAPHY for 1876.

nothing touches the paper, for the very slightest touch will cause a stain in the development. Prepare

Silver nitrate...	...	...	...	$2\frac{1}{2}$ ounces
Glacial acetic acid	...	...	...	$2\frac{1}{2}$ "
Distilled water	...	...	...	40 "

Now float a sheet of your iodized paper on this (smooth side downwards) until the purple shall have turned an uniform yellow, which is silver iodide. Allow it to rest for one minute; after this, remove and immerse in distilled water, where it should remain for two or three minutes; if to be kept for some time, remove to another dish of distilled water. Place now on clean white blotting-paper, face upward, and remove by blotting-paper *all* moisture from the surface (these sheets can be again used for ironing out the wax by-and-bye); then place between blotting-paper, or hang up to dry; when *quite* dry, place in your dark slides. Next prepare

Gallic acid	...	...	...	200 grains
Spirit of camphor	...	...	...	1 drachm
Distilled water	...	...	...	40 ounces

This is a saturated solution of gallic acid; unless preserved from the air it decomposes; the spirit of camphor is added to preserve it. When about to develop, filter, and add to every five ounces one drachm of the following solution:—

Silver nitrate	...	...	...	30 grains
Glacial acetic acid	...	...	...	$\frac{3}{4}$ drachm
Distilled water	...	...	...	1 ounce

Pour into your dish quickly, and *immediately* float the picture side of your paper (which is slightly visible on it), being very careful that there be sufficient liquid to prevent the paper from touching the bottom of the dish. Constantly watch until the picture becomes visible on the back, and the paper has a kind of brown, greasy appearance. Continue the development until, in holding up a corner when the sky is before the light, you cannot see your finger when moved about between the light and the paper. If it be not dark enough before the silver gallate decomposes, you have under-exposed. Decomposed gallate of silver ceases to develop.

Do not, when examining your paper, lift more than the corner, as an oxide of gallate of silver forms *rapidly* on the surface like a crust, and, on replacing your picture, it causes innumerable

marble appearances; as also if you do not place your paper speedily on the solution in the first instance. It may be removed by drawing a sheet of blotting-paper over the surface of the solution. Remove to a dish of common water, and wash out the brown tinge caused by more or less decomposed gallate of silver.

When *well* washed, you may fix it by placing it in solution of sodium hyposulphite, one and a-half ounce to one pint of water, till every vestige of the yellow silver iodide be removed, after which wash in eight or ten different changes of water; you have then a fine, clear, and dense negative.

MISCELLANEOUS APPLICATIONS OF PHOTOGRAPHY.

INSTANTANEOUS PICTURES.

THE term "instantaneous" is merely a comparative term, and must be understood as expressing simply a *very* short exposure. In photographing street scenes, &c., short exposures are of the greatest use, and there are frequently occasions in art photography in which an accurate knowledge of the conditions for obtaining instantaneous pictures is essential.

The plates must be excessively clean, as the shortness of the exposure and the strength of the developer used render the slightest chemical dirt apparent.

A collodion containing a large amount of bromide is generally used, and it should be of a straw colour to give the best results. The addition of 1 to $1\frac{1}{2}$ grains of bromide to the ounce of ordinary bromo-iodized collodion is advisable as a rule. It is recommended that the different samples of iodized collodion in stock should be tested one against the other, by means of the cut stereoscopic plate (as described at page 13), and the most rapid and delicate selected.

A newly prepared bath (or nearly so) is an essential; the 40-grain (as described at page 16) will answer; a 50-grain bath will, however, ensure better results. With a highly-bromized collodion, the addition of a drop of concentrated nitric acid to the ounce of bath will often aid sensitiveness; with a collodion poor in bromide this addition must not be made. If doubt exist

as to the quantity of bromide, the more neutral condition of the bath had better be maintained.

The iron developer No. 3 (page 19) is suitable. Two other formulæ are given, both of which are effective.

Ferrous sulphate	...	...	...	60 grains
Water	...	...	...	1 ounce

Or,

Ferrous sulphate	...	...	...	60 grains
Formic acid	...	...	...	1½ drachms
Alcohol	...	...	...	quant. suff.
Water	...	...	...	1 ounce

A pyrogallie acid solution has also been used, viz. :—

Pyrogallie acid	...	...	...	20 grains
Formic acid	...	...	...	1 ounce
Alcohol	...	...	...	6 drachms
Water	...	...	...	1 ounce

It is of the greatest importance that the plate should be covered with the developer quickly. It matters little in this case if part of the free silver solution be carried off by the developer; in fact, it is advisable, as the lack of silver prevents too great a reduction on the higher lights before the detail is brought out.

It generally happens that instantaneous pictures require no intensification. If they should require it, the iron and citric acid formula is recommended, as it brings out detail. Care must be taken that harshness is not given to the negative from trying to force out detail, which, in reality, may only pile up the silver on the high lights without bringing up the half tones.

With bath dry plates instantaneous pictures can be obtained, though with less certainty than by the wet process. The great essential with these is that they should be freshly prepared, and be raised previous to development to a temperature of about 100° Fah. This may be managed by immersing them in water of that degree of heat. The developer should likewise be warmed to the same temperature. England's collodio-albumen process has answered well with the writer, the above precautions being taken. The collodio-bromide emulsion plates prepared with an excess of silver are very suitable for instantaneous pictures, more particularly those prepared with a preservative containing gum.

The gelatine bromide plates (see page 90) are particularly adapted for this same work.

A short-focus lens, having a good defining power, with a large stop, is to be preferred. A single lens has the additional advantage of having the smallest number of reflecting surfaces.

The best subjects for instantaneous photography are those in which there is but little contrast. Sea pieces and clouds form objects most suitable for artistic purposes. Trees are rarely rendered satisfactorily, owing to their non-actinic colour.

PHOTOGRAPHING THE INTERIOR OF BUILDINGS.

Interiors are often most interesting subjects for the camera. A few hints on the manipulations, &c., when wet plates are used for photographing such subjects, are given.

A collodion which has been iodized long enough to assume a dark straw colour, and to which a grain of bromide of cadmium has been used to each ounce, should be employed. Some photographers employ two collodions, one newly-iodized, and the other very old. A first coating is given with the new, and, after setting, a subsequent one is given with the other.

The plate on immersion in the bath should be kept in rather violent motion till all the greasiness has disappeared (which will be in about two minutes). It should then be taken out very slowly, so as to drain completely. Damp blotting-paper should be placed at its back, and the droppings absorbed in the slide by a strip placed at the lower edge; by this method a plate may be exposed for a long time (two or three hours) without staining or drying. The rationale of this is as follows:—The plate is kept in the bath long enough to change the iodides into iodide of silver, while the *bromide* of silver is only partially formed. The free nitrate of silver left on the plates is absorbed by the bromides to complete the change. This prevents the crystallization of the nitrate of silver on the film. The *nitrates* of cadmium, &c., formed, being very deliquescent, retain sufficient moisture to prevent the film drying.

The exposure for an interior can rarely be too long. The same rule holds good as in ordinary wet-plate photography, viz., expose for the detail in the shadows.

If the sun shines into the windows of the building, its light may advantageously be used, by the use of a looking-glass or tin reflector. Those parts in the deepest shadows are those to be

illuminated by reflected light. The reflector should always be kept moving about, otherwise an opaque patch will be produced on the negative. Magnesium wire may be burnt in one of Solomon's lamps, to take the place of the sunlight, the same method of procedure being adopted. When a window through which white light is pouring, which is not the principal source of illumination, has to be included in the picture, a yellow cloth or blind should be placed over it till the exposure is nearly complete. This prevents halation or blurring.

No. 3 Developer (page 19) should be used, the contrasts between the high lights and deep shadows being *usually* extremely marked.

Intensification is rarely necessary; if it be, the ordinary formulæ are recommended.

It may happen, no matter what care is taken, that markings like slug tracks and oyster shells show on development. These may be caused by aldehyde in the collodion or developer; by using too strong a bath or developer; and by the drying of the film. Generally they may be obliterated by brushing a fine tuft of cotton wool over the defective spots, either when the film is damp and kept covered with water, or when dry. The latter condition is the safer.

The removal of the markings should, in all cases, precede intensification, as the silver would be deposited on them instead of on the image beneath. This would leave the negative intensified at all parts except on those from which the deposits had been removed.

Another method, that has been suggested by Mr. Jabez Hughes, is to wash the plates after sensitizing, and after exposure to re-dip them.

The plate, after having been fully sensitized, is placed in a dish of distilled water, and washed till all greasiness disappears. It is then drained, and placed in the slide, with blotting-paper at the back. After exposure, the plate is re-dipped in the bath for at least a minute, when it is developed in the usual manner.

Another method is to wash the plate thoroughly after sensitizing, and float over it any of the given preservatives for dry processes, and develop by the alkaline or gelatino-iron development. Perhaps the most simple preservative to employ is a wash of beer to which one grain per ounce of pyrogallie acid has been added.

For interiors, perhaps the most satisfactory plan is to use a dry plate process, and that process is to be recommended which gives the most dense film, since blurring round the bright lights is thereby avoided. We can recommend the washed emulsion process with the beer preservative as being perhaps the most easily prepared, and the one in which the film is not rendered transparent by the preservative. A recent feature in this species of work is the photographing of interiors when illuminated by gaslight or the light of paraffine lamps. Mr. W. Brooks and Mr. Bennett have each succeeded admirably in this direction by the use of the very sensitive emulsion processes which they employ. The exposure, of course, is prolonged, but much less so than would be necessary with the wet process. With the latter success would be, to say the least, in any case doubtful.

COPYING PLANS, ENGRAVINGS, ETC.

A most important branch of photography is the copying of plans, sketches, &c. The greatest care should be exercised in the selection of lens and chemicals for the operation, success depending mainly upon them.

A single lens should not be used, owing to the curvature given to the marginal straight lines. This confines the choice to the landscape, doublet, and triplet, and to portrait combinations. Of these the doublets are the most satisfactory. With lenses obtained from first-class makers there is no distortion; the reflecting surfaces are fewer in number than in the triplet combination, and therefore it is to be preferred. The triplet seems to have a flatter field; in bright weather, therefore, when there is plenty of actinic light, it may be used with advantage. Portrait combinations also answer; the general objection to them, however, is that the image is so concave as to be out of focus at the margins, unless one of large diameter be used. Dallmeyer's D lenses have less of this objection. With a large stop they answer for portraits, whilst with a smaller one they answer for copying purposes. No. 6 D lens, by the above maker, will answer for copying plans on an 18 by 15 plate. If a lens of this size be not at hand, the above maker's rapid rectilinear or triplet (for 18 by 15) may be substituted.

If the plan have to be reduced by photography with the aid of a portrait combination, it is preferable to have the front lens next the plan to be copied; if it have to be enlarged, the combination should be inverted, and the back lens placed in front.

Unless a special camera be employed, the rendering the image of the plan, &c., to be copied of a particular size entails considerable labour in shifting the board on which the plan, &c., is fixed.

The following mode of attaining parallelism to the focussing screen answers well. On the centre of the board on which the drawing, &c., is to be fastened, a small mirror may be temporarily fixed. This latter should be strictly parallel to the surface of the board. The point corresponding to the centre of the lens should be accurately marked on the ground glass. On the lens itself an open cap should be fitted, furnished with two cross threads, intersecting on the prolongation of the axis of the lens. The image of these cross threads will be reflected by the mirror, and should be focussed. The board should then be tilted or slewed round till the image of their intersection coincides with the point marked on the ground glass.

The board will now be parallel to the ground glass; the mirror being removed, the drawing may be fixed on to it, and focussed as usual. A neat stand for the board will readily suggest itself, by which it may be moved parallel to the position thus secured, so that the distance necessary to give the exact size required may be attained.

The mirror may be let in flush with the board, thus obviating the necessity of its removal for fixing up the drawing.

A direct light, coming in an horizontal direction, is generally to be preferred for copying, as the texture of the paper is hidden by it. If a vertical light be used, the shadows of the irregularities on the surface of the paper may mar the purity of the whites.* Should the plan be shaded in flat tint, it may be necessary to copy it in direct sunlight, as Indian ink and sepia, and some other colours, are of such a non-actinic nature as to make but slight impression on the sensitive film; strong light lightens up the shades, which are only dark by comparison. For like reasons, plans or engravings on paper which, through age or other causes, has turned yellow, should be copied, if possible, in sunlight.

The light for copying oil pictures should come from the direction in which the light has been supposed to come in the

* In copying certain classes of drawings the writer has found that light admitted through a funnel-shaped box, formed of tissue paper stretched on laths, prevents the irregularities of the paper showing. In copying prints from albumenized paper, &c., the same procedure may be followed.

picture itself. A painter "loads" his canvas in such a manner as to give the best effect to his picture when viewed in that particular light.

For copying pictures in plain black and white, a simple iodized collodion is recommended by many skilful photographers. In practice it has been found that a bromo-iodised collodion yielding intense negatives answers well for ordinary work. The addition of a grain or two of pyroxyline (or, better still, papyroxyline) which has been washed in dilute ammonia will often cause a limpid collodion to become fit for copying purposes. The alkaline reaction in collodion gives intensity, and this is further increased by the addition of the pyroxyline. Should a painting, either in monochrome or colours, have to be reproduced, the ordinary bromo-iodized collodion is recommended.

The bath should be free from any impurity, and may be of the ordinary strength.

For plans or line drawings, developers Nos. 1 and 8 (pages 18 and 20) are recommended. The iron may be used even weaker than in No. 1, and may be as follows:—

Ferrous sulphate	...	...	...	5 grains
Glacial acetic acid	...	...	...	10 minims
Alcohol...	...	...	...	quant. suf.
Water ...	...	...	...	1 ounce

With a simple iodized collodion, pyrogallic acid may be resorted to as a developer. Should this be decided upon, half the acetic acid given (formula, page 18) should be added, otherwise the deposit may become too crystalline in character. In winter, or when the light is weak, the iron developer should invariably be employed.

For ordinary paintings a twenty-grain developer may be taken as a standard solution; a stronger or weaker one may be necessary, according as great or little contrast is desired.

Negatives of plans drawn in lines should never be fully developed, and they should be slightly under-exposed. When the reduction on the whites has taken place, the developer should be washed off, and the negative fixed. By this method deposit on the lines is avoided.

The negatives will require intensification. In rare instances the simple application of No. 4 (page 23), followed by the pyrogallic intensifier, will suffice. Should this, however, not give sufficient density, either Nos. 7, 8, 9, or 10 (pages 24 and 25) may be tried in addition.

It requires considerable practice in manipulation to prevent (1st) a stain forming on the lines from the pyrogallic acid intensification, or (2nd) the lines from becoming filled up by a deposit from the intensifier after fixing.

It is safer, after using a solution of mercury, to let the negative dry spontaneously. Rapid drying is apt to cause the film to split.

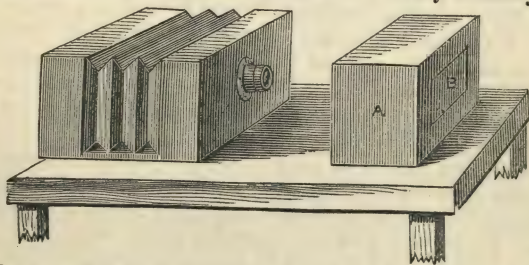
The ordinary procedure of wet-plate intensification should be carried out in copying paintings.

For copying, it is useful to know the equivalent focus of a lens, as by it the distance of a plan, &c., from the lens may be known. To determine it, see Appendix.

PRODUCTION OF TRANSPARENCIES.

The production of positive transparencies on glass from a negative is necessary, as a rule, for the multiplication of negatives, reversed or otherwise. The following are modes of production by the camera or by contact printing.

Transparencies by the Wet Process.—When it is determined to use the camera, if a proper copying camera be not at hand, the following substitute may be employed. A is any ordinary rough



box, the top of which is removed. Out of the bottom is cut a rectangular portion, B, just large enough to hold the negative from which the transparency is to be obtained. Small pieces of wire are placed across the angles to support the face of the negative. When the latter is placed in position, a couple of pins inserted at the top and bottom of the outside of the opening will prevent it from slipping. Placed as shown in the figure, the light from the sky being reflected through it by a mirror or by a perfectly smooth sheet of white paper, a transparency may be obtained merely by treating the negative as if it were a plan, &c., to be

photographed. It has usually been considered that the box holding the negative and the camera ought to be connected together, no diffused light having access to the front of negative. In practice this is found unnecessary, and where the negative is dense the diffused light is absolutely an improvement. Should it be found advantageous to exclude all light, a couple of battens placed across the negative, and a cloth thrown over them, will answer the purpose. An opening through the outside wall of the dark room may be used to hold the negative. A mirror placed at about 45° with the horizon, and covered over with plate glass as a protection from dust and rain, reflects the clear light of the sky through the negative.

It need scarcely be said that the focussing should be *very carefully* attended to; a common pocket magnifier is useful where extreme definition is to be obtained on the ground glass.

The negative for a brilliant transparency should be slightly less dense than one suitable for good printing. It is, however, by no means to be inferred that a negative of even great density cannot be copied, but only to be understood that the less dense one will give the finest results with the least trouble.

The use of a highly-bromized collodion is to be recommended. For ordinary printing-negatives the addition of one grain of bromide to the ounce will suffice; for a negative of the weak type the bromide may be omitted; whilst for a dense negative the bromide may be added up to three grains per ounce if the collodion will bear it. The bromide should be added from five to six hours before the collodion is required.

The exposure should be long enough to cause the *minutest* detail in the negative to be apparent in the transparency. On drying, the points of bare glass should be very few; if not, it may be taken for granted that the exposure is too short. No fixed rules can be laid down for the length of exposure; the operator must use his judgment.

The development is carried on with a very weak developer, the strength varying with the density of the negative to be reproduced; the denser the negative, the stronger the developer should be. For a negative of medium density the following may be used:—

Ferrous sulphate	...	...	...	5 grains
Glacial acetic acid	...	...	...	5 minims
Alcohol	...	...	...	quant. suf.
Water	...	...	...	1 ounce

For a *very* dense negative the ordinary 30-grain iron developer (page 19) may be used. Should there be too much contrast, add more bromide to the collodion, and use a stronger developer; if too little, diminish the quantity of bromide, and use the weak developer. Intensification may be carried on to such a point that on looking through the glass the *deepest* shadow appears nearly opaque.

The transparencies should be fixed with sodium hyposulphite (see page 27), in order that the delicate details may not be eaten away in the slightest degree.

The ordinary colour given by silver is not an agreeable one, and it is generally necessary to tone the image. This may be effected by a platinum salt, a gold salt, or iridium salt, or by a mixture of any or all of them. The formulæ are as follows:—

No. 1.—Ten-grain solution of platinum-tetra-chloride... .. 1 drachm
 Nitric acid 12 drops
 Water 10 ounces

No. 2.—Gold tri-chloride... .. 1 grain
 Hydrochloric acid 6 drops
 Water 10 ounces

No. 3.—Iridium chloride... .. 1 grain
 Hydrochloric acid 12 drops
 Water 10 ounces

If a mixture in equal quantities by measure of Nos. 1 and 2 be taken and flowed over the plate, a pleasing tone will be given. When toning with gold, a pink deposit is apt to form on the transparent portions, which spoils the effect. Sometimes the platinum solution by itself will give rather an inky colour.

Transparencies by Contact Printing with Dry Plates.—Transparencies may also be made by placing dry plates in contact with the negative in any ordinary printing frame. The exposure may be made by opening the window of the dark room for from half a second to twenty seconds in dull weather, or it may be given by the light from a strong gas jet. With an Argand burner of 12-candle power, and with the frame six inches from it, an exposure of from two seconds to six minutes will be required, according to the sensitiveness of the plate for the particular light employed. With gum-gallic plates the colour given by development (if double the quantity of gelatine solution be

added to the iron) will be generally of a warm black, which needs no toning.

Transparencies by Contact with an Albumen Film on Glass.—

The next method is one with which most beautiful transparencies may be produced, and although rather more troublesome than the processes which have been described, is well worth the attention of photographers who may have to make enlargements.

The following are prepared :—

No. 1.—Good and ripe bromo-iodized collodion.

No. 2.—Albumen from fresh eggs... 10 ounces
Acetic acid... 1½ dr.

To prepare this the albumen must be well stirred with a rod, and then allowed to stand twelve hours, when it is filtered through sponge or washed cotton wool. Next 40 minims of ammonia (.880) are added, together with—

Ammonium iodide ... 60 grains
Ammonium bromide ... 10 „

Dissolved in 6 drachms of distilled water.

This, kept tightly corked, and in a cool place, will remain fit for use for a couple of months.

No. 3.—Silver nitrate ... 480 grains
Acetic acid ... 3 ounces
Water ... 8 „

A clean glass plate (given a substratum, see page 56, by preference) is coated with No. 1 in the ordinary manner, and well washed under the tap. It is then coated with No. 2, which is allowed to drain away, carrying with it any superfluous water. No. 2 is again applied, pouring off and on from each corner in succession; and finally it is allowed to rest on the plate for a minute, after which it is returned to the bottle. The plate is next set up to dry in a drying cupboard, standing on five or six thicknesses of blotting-paper. When thoroughly desiccated, it is *slowly*, and without stoppage, dipped into a bath of No. 3, and kept in it for from half a minute to a minute (a longer time than the latter is hurtful), and after withdrawal it is washed under the tap for a minute, and finally rinsed with distilled water. An examination of the film will now show if the plate is defective in any particular. Streaks may be removed by a tuft of fine cotton wool soaked in water and applied gently. It is set up to dry in the drying cupboard, and care must be

taken in this drying, as in the last, that it is not touched till thoroughly dry. It is now ready for printing, though a backing (see page 62) may be given it. When in contact with the negative it must be exposed for about fifteen seconds to the diffused light of a clear sky, or longer if the day be overcast.

To develop it, the following solutions should be prepared :—

A.—Pyrogallic acid	...	...	...	60 grains
Acetic acid	...	...	...	3 ounces
Citric acid	...	...	...	15 grains
Water	...	...	...	1 ounce
B.—Silver nitrate	...	...	...	30 grains
Water (distilled)	...	...	...	1 ounce

After removing the backing, wash the plate under the tap, and flow over it solution A, and return it into the cup, in which have been dropped three or four drops of B. It is well to warm the developing solutions up to about 120° F., as then the image will begin to appear rapidly and evenly. In about twenty seconds the shadows should show, and it should be fully developed in three or four minutes. When any signs of streaks are visible, the plate should be washed and the cotton wool tuft applied, after which the developing solution may again be flowed over the plate. When the details in the high lights are sufficiently out, the plate is washed, and is ready for fixing and toning.

The following bath is recommended :—

Sodium hyposulphite	...	...	...	16 ounces
Water	...	...	...	22 "
Gold trichloride*	...	...	...	4 grains

The plate is allowed to remain in this bath fifteen or twenty minutes, according to the tone required (a brown tone requiring least time), and is then thoroughly washed for half-an-hour, and allowed to dry spontaneously.

The great difficulty in this process is the liability of the film to blister, but much depends on the kind of pyroxyline used in the collodion. A horny film is sure to blister, whilst one on which you can write your name with a pin without tearing the adjacent parts of the film will probably be found everything that can be desired. Cold in any stage of the opera-

* This is best dissolved in two ounces of water, and added when dissolved.

tions is a great source of these blisters, hence all the solutions should be kept at a temperature not lower than 70°. This remark applies equally to the fixing solution. If long parallel cracks are formed in the film whilst in the sensitizing bath, the acetic acid is in defect; whilst streaks of unequal density are often due to plunging the plate too rapidly in it. A mottled appearance of the plate after sensitizing is due to the film being too horny. This defect will not occur if the collodion be old, and sensitized, at least partially, with ammonium salts. An excess or defect in exposure is easily recognized by the appearance of the developed image. It is not a bad plan to make the exposure by artificial (such as gas) light of a known intensity.

Transparencies by Contact Printing with Collodio-Chloride.—The collodio-chloride process may also be adopted. A glass plate should be albumenized round the edges, as for dry processes, and is coated with the collodio-chloride (page 139). When dry, the film is fumed by holding it over the mouth of a bottle containing ammonia, and then moving it till the entire surface has received the vapour. The plate is now brought into contact with the negative in a pressure frame. If strips of paper be gummed on to two of the corners of each plate, it may be examined without danger of loss of register during printing. A tolerable guess may be made of the progress of exposure by opening half the frame and looking through the two plates. It will usually be found that the print on the collodio-chloride does not possess sufficient vigour. The necessary amount is given by flooding it with—

Gallic acid ...	...	...	...	75 grains
Lead acetate ...	...	...	...	50 "
Acetic acid ...	...	...	...	2 drachms
Water ...	...	...	...	20 ounces

To this a few drops of a twenty-grain solution of silver nitrate should be added. When the intensity* is sufficient, the plate is washed, and then fixed with weak sodium hyposulphite. The image may be toned as given above.

Transparencies by the Carbon Process.—Another method of producing transparencies is by carbon printing. The gelatine is transferred to glass (which has had a slight trace of waxing

* The intensity increases on drying, therefore a certain allowance must be made.

solution rubbed over it) instead of to the zinc plate. The picture in this case will be reversed,* which is an advantage in mounting, as the ground-glass protects the film.

Mounting Transparencies.—In mounting a transparency, some translucent substance must be placed behind it. Ground-glass is usually employed, the rough surface being placed on the outside. Another better method is to dissolve to saturation white wax in ether. Filter, and to each ounce of solution add another ounce of ether. Flow over the reverse side, and allow to dry. After twenty-four hours the wax will give a beautiful transparency to the picture. With all except the carbon transparencies, the following may be substituted:—

Flake gelatine ...	...	...	...	2 ounces
Glycerine ...	...	...	...	$\frac{1}{4}$ ounce
Water ...	...	...	...	6 ounces

The gelatine should be allowed to soak in cold water till it is thoroughly swelled, and then dissolved by placing the vessel containing it in hot water. Just previous to use, two ounces of new milk heated to 90° F. should be added to the above amount; the whole should be well stirred together with a glass rod, and sufficient of the mixture poured from a measure or jug through fine muslin to cover the plate, which must have been *accurately* levelled. It should be allowed to set, and then be dried spontaneously in a warm room. If the transparency be reversed, the gelatine should be poured on the film side; and when thoroughly dried, the film may be stripped off. The picture may be cut out and bent to any form after varnishing; for instance, lamp-shades may be composed of a set of prints thus produced.

If two hundred grains of zinc oxide replace the milk, we have Mr. Burgess's Eburneum process. The solution, with the oxide added, should be kept warm, and allowed to stand six or eight hours before being allowed to solidify. The frothy top layer, and the bottom layer containing the coarse particles, are removed, and the solution is to be re-melted and poured on the plate as above. About four ounces of solution should cover a 12 by 10 plate.

* In producing transparencies in the camera, the same reversal may be effected by turning the film-side of the negative away from the lens. The glass must be absolutely free from flaws to give a perfect result.

REPRODUCTION OF NEGATIVES.

In all cases (excepting when the reproduced negative is to be reversed) a rather thin transparency must first be made. Any of the methods given in the last article may be adopted. The transparency is treated in the same way as the negative. From a carbon transparency, however, a negative cannot be made by contact printing, as, being raised in what will be the high lights, the surface of the dry plate or collodio-chloride film is prevented from being in contact with the picture. It will be noticed that enlarged negatives can be produced either by making an enlarged transparency, or by enlarging the negative from it in the camera. In all cases of enlargement the camera must be employed for one or the other; but it is strongly recommended that the transparency be enlarged, as then only those defects due to the negative are magnified. The one exceptional case where a negative can be reproduced successfully without a preliminary transparency is by the collodio-bromide process. The negative should be placed in the carrier in front of the lens, with the film side outwards. If a dry collodio-bromide plate be used, it is exposed and developed by the alkaline method, the development being carried on to such a point that in the deepest shades the metallic silver is apparent, by reflected light, at the back of the plate.

A trace of fog is not objectionable, if the negative to be copied be very dense. *The plate is not fixed*, but dilute nitric acid (one of acid to one of water answers) is poured over the film. This dissolves away the reduced silver, and leaves a negative image formed of silver bromide. The plate is next well washed, and a very dilute solution of ammonia is floated over the film to neutralize any acid, after which it is taken into the light, and developed with the alkaline or ferrous oxalate developer. This reduces the silver bromide to the metallic state, and gives the required negative. The image, if weak, may be intensified with pyrogallie acid and silver.

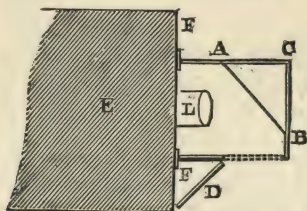
The same procedure is taken if wet bromide of silver be used. A plate is treated with collodion containing eight grains to the ounce of cadmium or ammonium bromide, or a proportion of each. It is sensitized in an eighty-grain bath for ten minutes, or the forty-grain bath for twenty minutes. After thorough washing, any one of the preservative solutions given for dry plates is flowed over it, and the exposure takes place whilst it is wet. The ordinary alkaline development is then proceeded with, and the remaining operations are as above described.

REVERSED NEGATIVES.

For photo-mechanical printing, and single transfer carbon printing, reversed negatives are essential. Their production may be divided into three classes:—1st, reversed negatives taken in the camera; 2nd, negatives reversed by reversing the collodion films of the originals; 3rd, reproduction from other negatives.

In the first case, the negative should be taken by means of a reflector, from a flat plate or glass silvered externally.*

The accompanying sketch gives an idea of what is required.



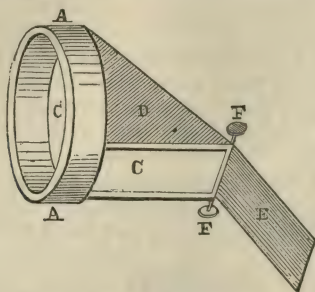
E is the camera; L the lens; A C B D is the section of a hood round which is fitted a flange (F F) which can be screwed into the camera. A B is a mirror, as above described, which is placed at an angle of 45° with the axis of the lens, and so adjusted that the centre of the mirror is its continuation; D is a small door, which can be opened or shut at pleasure. The object to be photographed is reflected from A B to the lens, and a little consideration will show that the image will give a reversed negative.

Another plan of obtaining a reversed image is by using a right-angled prism fitted on to the lens.

A A is a flange that fits on the lens, and takes the place of the cap; C C is a right-angled glass prism, whose breadth is equal to or greater than the diameter of the front glass of the lens. All the surfaces are enclosed in brass mounting, excepting C C, care being taken that the surface opposite to the right angle is not in contact with the surface of the glass; E is a shutter for exposure; F F, screws for clamping E.

* The mode of silvering the mirrors is given in the Appendix.]

The image undergoes total reflection by the prism, and this gives a reversed negative. There is no particular direction to give in



using either the mirror or the prism, excepting that both should be free from dust, and the former from tarnish as well.

An ordinary negative may be reversed by transferring the film. The best method is that of coating it, whilst unvarnished, with a solution of india-rubber in benzole, of the consistency of thin collodion* (india-rubber paste dissolves readily in this menstruum). When drained, it is allowed to dry. Transfer collodion, made as follows, should then be flowed over the surface, and allowed to dry thoroughly:—

Ether .730	...	...	...	5	ounces
Alcohol .805	...	...	...	10	„
Castor oil	...	...	...	$\frac{1}{4}$	ounce
Pyroxyline	...	...	...	$\frac{1}{4}$	„

The plate should then be immersed in cold water for a few minutes, or until the film seems to become loose. Should this not take place in a reasonable time, one ounce of sulphuric acid may be added to each gallon of water, which will aid the detachment. The film should be cut with a penknife round the edges, and should be gently stripped off whilst in the water. It should then be turned over and laid on a clean plate (or one slightly gelatinized) whilst still floating in the water. A soft squeegee, as for carbon printing, may be used to expel the liquid between the two surfaces, and the plate should be set aside to dry, after which it may be varnished and used as an ordinary negative.

* About one grain to two grains to the ounce.

Reversed negatives may be produced from other negatives by the processes mentioned in the last article, and also by placing dry collodio-bromide plates *in contact* with the negatives, dissolving away the image with nitric acid before fixing, and proceeding as before shown. (Also see Powder Process.)

PAPER ENLARGEMENTS BY DEVELOPMENT.

Albumenized paper should be sensitized in the following bath :—

Silver nitrate ...	...	...	...	40 grains
Glacial acetic acid ...	...	...	...	30 minims
Water ...	...	...	...	1 ounce

and developed with gallic acid.

The gallic acid solution may be made as follows :—

Gallic acid ...	...	...	...	3 grains
Acetic acid ...	...	...	...	5 minims
Water ...	...	...	...	1 ounce.

The paper is immersed in a dish of this fluid, and the development takes place rapidly if properly exposed. Remembering that it is a positive print that is required, the purity of the whites must be preserved, and the development stopped before any deposit takes place on the highest light. When properly developed, the print should be taken from the developing dish and *well washed*. Any of the ordinary toning baths will give it an agreeable tone. It should be fixed, as usual, with sodium hyposulphite and water.

Plain paper may be salted with—

Sodium chloride ...	...	...	...	100 grains
Hydrochloric acid ...	...	...	...	6 minims
Water ...	...	...	...	12 ounces

Or,

Sodium chloride ...	...	...	...	6 grains
Potassium iodide ...	...	...	...	2 "
Ammonium bromide ...	...	...	...	1 grain
Water ...	...	...	...	10 ounces.

The paper is immersed for two or three hours, and then dried. It is then floated for three minutes on the following solution :—

Silver nitrate ...	...	...	...	1 ounce
Citric acid ...	...	...	...	8 grains
Water (distilled) ...	...	...	...	8 ounces

When moderately dry, the paper is pinned on a board, and placed in the camera or its substitute. A *faint* image of the negative should be visible, and then it may be developed by—

Pyrogallie acid...	...	...	...	2 grains
Citric acid	...	...	...	1 grain
Water	...	...	...	1 ounce

Sufficient of this must be taken to well cover the paper (which should previously have been stretched on a glass plate, by turning the edges underneath it); no stoppage in the flow must be allowed whilst covering the surface. As soon as the proper contrast is obtained, the paper is well washed, and, if necessary, toned. The prints are finally fixed in—

Sodium hyposulphite	...	...	...	1 ounce
Water	...	...	...	16 ounces

They are kept in this till the high lights lose any trace of colour, when they are withdrawn, and washed in the ordinary manner as for prints on albumenized paper.

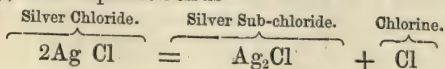
Artistic *enlargements* are also produced by taking an enlarged transparency of the negative, and printing it on ordinary albumenized or salted paper to a depth beyond that ordinarily necessary for silver printing. (See "Silver Printing.") The print is then fixed, washed, dried, and waxed (as described at page 99) for the calotype process.

Enlargements on paper may also be effected by the calotype process, and call for no very special remark. A reversed paper positive, enlarged or otherwise, may also be obtained direct in the camera by a process due to Mr. Fox Talbot. Calotype paper is sensitized in the ordinary manner, exposed to light for a short time, then immersed in a solution of potassium iodide, and well washed. It is now exposed in the camera for ten minutes, and developed in the usual way with gallo-nitrate of silver. The resulting picture is a positive, supposing a positive has been copied. The same mode of procedure can be adopted with iodized plates.

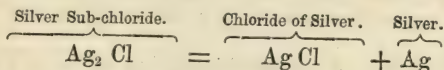
(The kind and amount of light admissible for preparing and developing wet and dry plates and paper prints will be found in the chapter relating to the "Dark Room.")

SILVER PRINTING.

SILVER chloride darkens when exposed to the action of sunlight. It assumes a deep violet tint, and, if it be immersed in water, traces of free chlorine will be found to have been liberated. The light then, by its vibratory energy, decomposes the molecule of silver chloride into a sub-chloride and chlorine gas.* Chemically, it is expressed thus—



Silver chloride is formed by double decomposition, similarly to the iodide (see page 3). It is soluble in sodium hyposulphite, potassium cyanide, and also in ammonia. When silver chloride has been acted upon by light, and the sub-chloride formed, the hyposulphite or other fixing agent re-converts the sub-chloride partially into silver chloride, and partially into metallic silver. Thus—



The fixing agent dissolves the silver chloride, leaving the metallic silver unaltered.

When silver nitrate is brought in contact with an organic substance, the resulting compound is found to be affected by light in a somewhat peculiar way: the compound slowly darkens to a reddish tint; the exact chemical reaction that takes place is very complex to trace, but it may be accepted that an oxide of the organic matter and silver is formed. This oxide is stable, unlike the silver oxide, and is not acted on by fixing agents to any great extent.

If a paper be coated with albumen (say) in which has been dissolved a certain quantity of a soluble chloride, and floated on a silver solution, both chloride and albuminate of silver are formed. It depends, however, on the strength of the solution as to what proportions of each are present, owing to the fact that

* It seems probable, however, that the sub-chloride is subsequently oxidized to a certain extent, and that this oxidation is effected not only by what are called the actinic rays, but also by those which are usually inoperative. This, perhaps, may account for the difference that is perceptible between a print which prints slowly, and one in which the action of light is rapid.

the organic compound is much slower in formation than the chloride, and has less affinity for the silver. If the silver solution be not sufficiently strong, the chloride may rob that portion of it, with which it is in contact, of all the silver before any (or, at all events, sufficient) albuminate has been formed, the molecule being composed almost entirely of silver chloride. The stronger the silver solution, the more "organate" will it contain; whilst if it be very weak, very little will be present. Hence it is that with albumenized paper which is weakly salted with a soluble chloride, a weak sensitizing bath may be used; whilst if it be rich in the chloride, it must be of proportionate strength.

One other chemical reaction in printing must be considered—viz., that of the free silver nitrate, which is always present. During printing, as stated, the silver chloride becomes reduced to a sub-chloride, evolving chlorine gas. This chlorine has a stronger affinity for silver than has the nitric acid (with which it is in combination in the silver nitrate), and, consequently, it combines with the silver, forming new silver chloride,* which, in its turn, enters into a combination with the organate, liberating nitric acid.

This freshly-formed organo-chloride, in its turn, blackens by the action of light, and adds to the strength of the image formed. If the free silver nitrate were absent, we should have the chlorine attacking the darkened organo-chloride of silver already formed,† and partially bleaching it. The result would be "measly" or mealy prints—i.e., prints in which minute red spots alternate with darker ones in the shadows after fixing.

From the first part of this article it would be gathered that as the silver sub-chloride is much more acted upon by a fixing agent than the product of the organate *after* it has been considerably affected by light, the molecules formed of the organo-chloride of silver, when only partially acted upon by light, would be much more easily attacked by the fixing agents than when fully acted upon. This is the case: the blacker an image formed by the organo-chloride becomes, the less it is attacked by the fixing agent, and, as a consequence, the half-tones of a picture are attacked by it more than the shadows.

* Probably together with hypochlorous acid.

† Thus $\text{Ag}_2\text{Cl} + \text{Cl} = 2\text{AgCl}$, leaving the organate of silver coloured, whilst the subchloride of the molecule was bleached.

The most important of the organic substances used in printing is albumen. Hitherto it has been used in preference to any other organic compound, on account of the delicate film it forms, and the beautiful colour the print takes by the production of the albuminate of silver. The albumen should be used fresh, and in a slightly alkaline condition. The principal commercial objection to its employment in such a condition as the foundation of the picture arises from the difficulty that is experienced in coating the paper evenly with it. When the albumen gives a slightly acid reaction, paper is easily coated, though toning is retarded, and inferior pictures are the result.

Gelatine is the next important organic substance used in photography, as it frequently forms the sizing of paper. The organic silver compound formed with gelatine gives redder tones than the albuminate.

Starch imparts a more purple tint to the picture than the foregoing. Those papers sized with this substance yield the pictures, on toning, of a bluer tint.

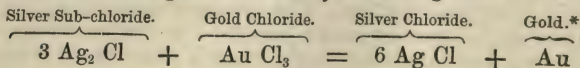
Two kinds of paper are principally used for albumenizing—Rive and Saxe. They both are starch-sized papers. The latter is much more porous, and consequently less glossy, than the former. Rive paper is, however, tender when wet, and tears easily when used in large pieces, such as required for large prints. Saxe, therefore, is preferred for large prints, whilst Rive is admirably adapted for *small* pictures where great gloss is requisite. Saxe paper can be rendered nearly as glossy as Rive by doubly albumenizing and rolling.

Other papers generally give inferior tones to those above specified, though they are constantly employed.

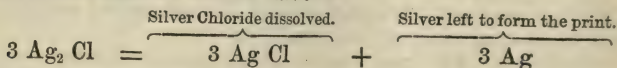
Toning a Picture.—If a picture printed on albumenized paper or ordinary salted paper (see pages 125 and 126) were at once immersed in the fixing bath, the resulting colour of the image would be of a disagreeable foxy red. In order to remedy this, it is usual to tone the picture by means of a solution of gold.

Supposing a print to be thoroughly washed, and immersed in a dilute solution of gold terechloride, the following phenomena would present themselves: the picture would gradually bleach, and a blue deposit would take the place of the more vigorous red image, and, on immersion in the fixing bath, the print would be of a most feeble character. The reason of these changes is this: the chlorine from the gold would attack the silver subchloride,

and, while depositing as a metal, would in reality convert the image back to the state of chloride; owing to one atom of gold combining with three atoms of chlorine, the deposited metal would be much less than if the subchloride had been split up into metallic silver and chloride by the fixing bath. Thus:—



In the second case we should have—



In order to avoid loss of vigour, it is usual to add some compound to the gold solution, and in certain cases to leave a small quantity of silver nitrate in the paper. When free silver nitrate is thus present, the compound added to the gold should be a retarder in its action, that when the free nitrate of silver is wholly washed out the compound should be an active absorbent of chlorine.

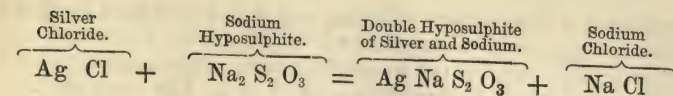
As an example of the first case, suppose the lime bath is used (see page 132), where we have a mixture of calcium hypochlorite and calcium chloride; the latter acts as a retarder to the deposit of the gold, as the chlorine from each of these is nearly equally attracted to the silver nitrate. Hence the addition of chloride of lime naturally checks the too rapid deposition of the gold, and the consequent attack on the silver sub-chloride.

As an example of the last case, where all the free nitrate of silver is washed out: sodium acetate has more affinity for chlorine than has the silver subchloride; hence there is but slight reduction in the depth of the print in fixing.

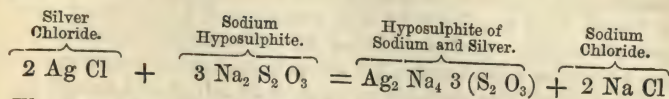
It has been assumed that the additions to the toning bath cause the formation of an oxy-chloride of gold. This may be the case, though the argument seems somewhat obscure. A simple experiment with stannous chloride added to the gold solution will give proof that the absorption of chlorine alone is necessary.

Fixing the Print.—Sodium hyposulphite is almost invariably used as the fixing agent, and a strong solution is necessary to secure permanency of the print. The reason is that there are two silver hyposulphites which can be formed:—

* It must not be forgotten that a gold chloride is formed when silver nitrate is added to gold terchloride.



and



The first double hyposulphite is nearly insoluble in water; the last is highly soluble. These two salts may be formed for experiment, in the first case by adding an excess of silver nitrate to the sodium hyposulphite solution, in the other by adding a large excess of the latter to the former. With the first we have a dirty-brown precipitate; with the latter there will be a perfectly clear solution. The student is recommended to try the experiment.

MANIPULATIONS IN SILVER PRINTING.

Albumenizing Paper.—The following is a useful formula for albumenizing paper:—

Ammonium chloride...	...	100 to 200	grains
Spirits of wine	...	...	$\frac{1}{2}$ ounce
Water	...	...	$4\frac{1}{2}$ ounces

When these are thoroughly dissolved, fifteen ounces of albumen* should be added. These ingredients then should be beaten up with a bundle of quills or a swizzle-stick. Constant shaking for half an hour in a bottle (holding about double the quantity of mixture prepared) will answer instead.

Having allowed the deposit in the albumen to settle, it is filtered through a sponge placed in a funnel, and from thence poured into a porcelain or other flat dish. The paper being cut into sheets of convenient size, the opposite corners of a sheet, the smooth side underneath, are then taken up by the manipulator (one in each hand), and a convex surface is given to it by nearly bringing the two hands together. The middle of the paper

* The eggs used must be nearly fresh. Each good sized English egg will furnish one ounce, whilst those obtained in the last will only yield five-eighths of an ounce on an average.

first touches the albumen solution, and the corners held by the hand are gradually brought down till the sheet floats on the liquid. The formation of air-bubbles on the surface of the paper is thus prevented, as they are squeezed out. The sheet should remain upon the solution a little over a minute, and should then be raised very gradually by one corner, and hung up by two corners* to dry. Should bubbles be inadvertently formed, the paper must be floated again, till an uniform surface is secured.†

When dried, the prepared paper may be rolled, and should be put away flat.

If the paper is floated much longer than stated above, the albumen, being prepared with an alkaline salt, is apt to dissolve the size and sink into the paper, thus destroying the gloss.

PLAIN SALTED PAPER.

Prints on plain paper are useful in certain instances. The formula for preparation is given :—

Ammonium chloride	...	...	60 to 80 grains
Sodium citrate	...	...	100 "
Sodium chloride	...	...	20 to 30 "
Gelatine	...	...	10 "
Distilled water	...	...	10 ounces

Or,

Ammonium chloride	...	...	100 grains
Gelatine	...	...	10 "
Water	...	...	10 ounces

The gelatine is first dissolved in hot water, and the remaining components of the formulæ are added. It is then filtered, and the paper is floated for three minutes, following the directions given on the preceding page. If it be required to obtain a print on plain paper in a hurry, a wash of citric acid and water (one grain to the ounce) may be brushed over the back of ordinary albumenized paper, and, when dried, that side of the paper may be sensitized and printed in the ordinary manner. For cold tones the wash of the citric acid may be omitted.

* American clips answer for holding the paper whilst drying.

† For other methods of floating see Handy-book on "Silver Printing" (Piper and Carter).

THE SENSITIZING BATH.

A good standard for a sensitizing bath is as follows:—

Silver nitrate ...	...	...	...	50 grains
Distilled water ...	...	...	...	1 ounce

This solution is suitable for most albumenized paper that is to be obtained in the market when it is required to print from good negatives of a fair density. The paper is floated on the sensitizing solution from about three minutes in hot weather to five in cold. The method of floating is similar to that given above for floating on the albumen solution.

Care should also be taken to withdraw the paper slowly, as the capillary attraction will remove nearly all excess of silver solution, and thus prevent a waste by the droppings, and a loss of time in drying. The paper should be hung up from one corner by an American clip, and a small piece of clean blotting-paper should be attached to the bottom corner to collect the excess of solution. This blotting-paper should afterwards be placed with the paper residues.

After a few sheets are sensitized, the solution will be found to be below strength. It can be roughly tested by the argentometer, which is a float showing the specific gravity of the liquid. The greater the depth of immersion, the lower the specific gravity, and consequently the less salts are dissolved in the water. Supposing that silver nitrate alone were dissolved in the water, the number of grains as indicated by the depth of immersion of the float would give the strength of the solution; but as other soluble matters are likewise to be found in it after paper has been sensitized, it is evidently an incorrect gauge. The method given in the Appendix is therefore recommended.

The sensitizing solution, after a day or two, will be found to become discoloured, owing to the albumen dissolved in the liquid. The method of freeing the solution from it is given in the Appendix.

When the albumenized paper is very nearly dry (but not so much as to wrinkle on unrolling it when it is removed from the clip), it should be placed in clean blotting-paper between boards, in order to be flattened for printing.

Should a negative be found very hard, a slight modification of the sensitizing solution will be found beneficial, supposing the ordinary paper is to be used.

Silver nitrate	...	...	...	...	30 grains
Water	...	...	...	...	1 ounce

The negative should in this case be printed in the sun. The more intense the light, the less contrast there will be in the print, as the stronger light more rapidly effects a change in the albuminate than if subjected to weaker diffused light. The reason for the reduction in quantity of the silver nitrate in the solution is given on page 122.

To print from a weak negative, the sensitizing solution should be :—

Silver nitrate	...	...	...	...	80 grains
Water	...	...	...	...	1 ounce

The printing should take place in the shade; the weaker the negative, the more diffused the light should be.

If a negative be dense, but all the gradations of light and shade be perfect, the strong bath, and, if possible, a strongly-salted paper, should be used. The printing should take place in sunlight.

With a very weak sensitizing solution the albumen may have a tendency to dissolve from off the paper; the addition of ten to twenty grains of sodium nitrate, or a drachm of alcohol, to the ounce of solution, will prevent the evil recurring.

If the baths be new, and no injurious vapours be present in the air, sensitized paper will keep for a couple of days in hot weather to a week in cold.

WASHED SENSITIVE PAPER.

A method of keeping sensitized paper for longer periods (say for a week or a fortnight) without discolouring has been introduced. It is more sensitive, tones more rapidly, and gives more uniform results than the ordinary sensitized paper; the negatives also may be more than ordinarily weak, and still good prints be obtained.

The paper, sensitized as usual, is passed through, *not soaked in*, face downwards, two or three changes of water,* and hung up to dry. The pads of the pressure frame must be fumed with ammonia previous to using the washed paper, in order to pro-

* All the free silver nitrate must not be washed away, otherwise the print will want depth in tone.

duce a rich print—the reason, apparently, being that the alkali combines with the liberated chlorine.* Colonel Stuart Wortley's plan of impregnating the pads with ammonia vapour seems the best method of applying it. He places all the pads to be used in a large box overnight, with a little strong ammonia in a saucer; by the morning they are sufficiently impregnated with ammonia vapour.

The sensitizing bath should not be acid. If a small quantity of silver carbonate† remain at the bottom of the bottle holding the stock solution, the acidity is prevented. A little powdered chalk added to the bottle answers equally well.

Colonel Stuart Wortley uses the following bath for sensitizing paper that is to be washed:—

Silver nitrate	...	...	...	...	35 grains
Lead nitrate	...	...	...	...	13 "
Sugar	...	...	...	...	2 "
Water	...	...	...	...	1 ounce

The washed paper may be stored between clean and dry blotting-paper, and pressed between two flat boards. The less air admitted to it the longer it will keep.

READY SENSITIZED PAPERS.

In the market there are two or three ready sensitized papers, which are printed, toned, and fixed in the usual manner. There is sometimes a slight lack of vigour in the resulting prints, however, which is partially overcome by fuming the pads as described above.

Mr. Hopkins has adopted a method of preserving ordinarily sensitized paper. He floats the sheets of albumenized paper on a 40-grain bath, as usual; then dries till nearly all the moisture is gone. He then places them between sheets of blotting-paper previously impregnated with sodium carbonate solution (about thirty grains to the ounce of water), and allowed to desiccate. The pile of paper he places under pressure, and withdraws the sheets as required.

Another plan of keeping paper in a sensitive condition is by adding from twenty to forty grains of citric acid to each ounce

* For further explanation, see Handy-Book on "Silver Printing" (Piper and Carter).

† The addition of sodium carbonate will form the carbonate of silver.

of silver nitrate solution. Many find this to give good results, whilst others find a lack of vigour after toning. The writer has recently been experimenting, and has found that if thoroughly washed paper be immersed in a solution of potassium nitrite it will also keep well, and that the resulting prints will be as vigorous as with unwashed paper, or as with washed but ammonia-fumed paper. This opens out future possibilities in printing, as the principle which underlies the process is the application of a chlorine absorbent to the silver chloride.

PRINTING THE PICTURE.

Skill is required for obtaining the most perfect prints from any negative, and it is only by paying attention to trifling details that the best results can be obtained. It should be remembered that no blind adherence to any rules will attain the object in view; printing requires thought to be exercised, as well as clean manipulation.

Should a picture print too black in the shadows—*i.e.*, attain a bronze colour—before the details in the lights have printed in, attention should be given to the rules to be found on page 128, and further improvement may be effected by shading these dark portions. This shading may be done either by temporarily placing a paper, whilst printing, or by gumming tissue paper cut to the proper shape, on the reverse side of the negative. On the deepest shadows two or more layers of tissue paper may be gummed, till the desired effect has been attained. In some cases cotton-wool may be placed over a spot which prints in too quickly; and, in extreme cases, where high lights are wanted, a skilful touch of the brush (using Indian ink or sepia) on the film side will give a piquancy to the print which cannot otherwise be obtained.

The prints from landscape negatives frequently show a want of atmosphere in the far and middle distance. In order to give it, the back of the negative should be covered over with tissue paper,* and the shadows in the distance should be made less obtrusive by means of a stump and powdered crayon. The foreground may be caused to approach by heightening its high lights. A golden rule to remember is, that the greater the

* The paper may simply be gummed round the edges of the negative, or it may be covered with starch and caused to adhere to the whole surface of the back of the plate.

distance of an object, the greyer the high lights, and less heavy the shadows.

The sky in some negatives prints in too deeply: a mask, cut to the outline of the landscape, and slightly raised from the surface of the negative, will give a graduated sky, which, if left too white, may be subsequently improved by "sunning" down. This sunning down is generally carried out by means of a sheet of non-actinic paper or cardboard, which is moved gently over the picture, leaving the upper portion of sky more exposed to the action of the light than the lower portion, the landscape itself being always completely covered up.

In many landscapes some secondary object may attract the eye by the brilliancy of its high lights. As the object of all artistic photography is to cause the eye primarily to dwell on the most important point, these bright spots, if they interfere with the effect of the picture, should be sunned down by shading all the print except that particular part. This may be secured by using a brown paper mask, cutting out the shape of the object to be toned down. For this object the negative should be removed, and a clean piece of glass substituted for it in the printing-frame.

Transparent spots in the negative may be touched out on the negative itself. Gum should not be mixed with the paint used, for reasons given at page 42. Opaque spots in the negative are always white in the print, and these can only be touched out on the print after it is fixed and dried.

In toning operations the print loses depth, varying in a great measure according to the toning bath used. An allowance in the printing should be made for this loss, the picture when taken out of the frame being considerably darker than what it should be when finished. To determine the proper depth of printing is, perhaps, one of the most difficult things in photography. Practice alone can help the student.

After the negative has been placed with the film side towards the back of the frame, a piece of paper the size of the plate should be placed on it. A felt or flannel pad should next cover the paper, and the back be placed over this.

The pad is principally used to cause an equal pressure to be exerted between the negative and the paper. Should the pressure be unequal, the paper will not be in contact at places, which will be shown by a fuzzy appearance at those parts of the print. Even when pads are used, it is not unfrequently the

case that this want of contact exists. If the paper has been dried in a moister, hotter, drier, or cooler atmosphere than that in which the printing takes place, the presence of the defect need cause no surprise. It is a good plan to let the paper remain in the printing room half an hour before the printing commences, and to place the sheet of paper on the negative in the frame, with the pad behind it, not pressing down the springs on the back. The negative, of course, should be face downwards on the floor to prevent the passage of light through it. After five minutes or so, the paper will have contracted or expanded sufficiently to enable complete contact to be maintained.

A great source of defective prints is their examination during printing. The frame should never be opened except in very subdued light, otherwise the whole exposed surface of the print may become discoloured, and the purity of the whites lost.

When prints are removed from the frames, they should be stored in a dark box, or between leaves of clean red blotting-paper in a large book.

TONING THE PICTURE.

The following toning baths are found to give good results. No. 1 is found to be very stable, and to give brilliant results:—

No. 1.—Gold tri-chloride	...	...	...	2 grains
Chlorinetted lime (chloride of lime.	2	..		
Chalk	...	...	...	1 teaspoonful
Water	...	...	...	16 ounces

If the water be hot, the bath may be used when cool; if not, a day should elapse between mixing and using it.

No. 2.—Sodium acetate	...	...	...	30 grains
Gold tri-chloride	...	...	...	1 grain
Water	...	...	...	10 ounces

To be mixed the day before it is used.

No. 3.—Chloride of lime	...	...	...	45 grains
Gold tri-chloride	...	...	...	45 ..
Chalk	...	...	...	45 ..
Sodium acetate	...	...	...	180 ..
Water...	...	...	...	15 ounces

(These to be mixed together, without filtering, from seven to

fourteen days before use. When required to use, filter out one ounce of solution, to which add eleven ounces of water.)

No. 4.—Gold tri-chloride	...	...	...	1 grain
Sodium carbonate	...	...	...	10 grains
Water	...	...	...	10 ounces

May be used immediately.

Other toning baths have been employed, but the foregoing are the principal used with albumenized paper.

Nos. 1, 2, and 3 will keep indefinitely. When the bath becomes inactive from lack of gold, it may be strengthened by a solution containing only one ounce of water to the above quantities of the other ingredients. No. 4 can only be used on the day it is made.

According to the minuteness of the grains of gold, so will it assume, by reflected light, colours varying from purple to a dirty-green. The organo-chloride of silver appears through this layer of gold, and the colours of the two mingling together give the different tones in ordinary prints. When a print is over-toned it becomes blue. This is due to the greater amount of gold deposited over the surface of the silver. The change in colour on the immersion of a print in the fixing bath is due to the solubility of the silver chloride.

With all the toning baths, excepting No. 2, a little of the free silver nitrate should be allowed to remain in the print—that is, before being immersed in the toning bath, the prints should not be too thoroughly washed (see page 123); whilst with the acetate bath it can be shown that all the soluble silver salt should be eliminated. In the first case, the prints should be washed in two changes of water, and the last change should show *decided* milkiness.* The paper is immersed in the water, with the albumenized face downwards, in order to prevent the silver chloride or carbonate (that may be formed from the soluble chlorides or carbonates in the water) being precipitated on the surface of the print, and the gold being deposited thereon. Should there be a deposit on the print, it is dissolved away by the fixing bath, and leaves minute untuned spots.

The dish for toning should be sufficiently large to contain a couple of prints side by side, but no more should be immersed than can be conveniently turned over without risk; eight or nine

* The milkiness is due to chlorides or carbonates, or sulphates.

medium-sized prints are generally found sufficient. The dish should be given a continuous and gentle rocking motion to cause the solution to flow over and between all the prints immersed, and thus is prevented the adhesion together of any two prints, and the consequent want of tone on those parts which have been in contact. A print must be toned a little deeper than it is intended to remain; for black tones a slight blueness must be perceptible. In all cases, however, *it should possess a rich colour before fixing.*

RESINIZED PAPER.

To Mr. Henry Cooper we are indebted for a valuable printing process, founded on substituting resins for albumen, or other sizing matter. The prints obtained by this process are very beautiful, and lack that gloss of albumen which is often called vulgar and inartistic.

The following are the two formulæ which Mr. Cooper has communicated to the writer:—

Frankinscence ...	...	...	...	10 grains
Mastic ...	...	...	...	8 "
Calcium chloride ...	...	...	...	5 to 10 grains
Alcohol ...	...	...	...	1 ounce

When the resins are dissolved in the alcohol, the paper is immersed in the solution, then dried and rolled. The sensitizing bath recommended is as follows (though the strong bath given at page 128 will answer):—

Silver nitrate ...	...	...	...	60 grains
Water ...	...	...	...	1 ounce

To the water is added as much gelatine as it will bear without gelatinizing at 60° Fah.

The second formula gives very beautiful prints, soft and delicate in gradation.

The paper is first coated with an emulsion of white lac in gelatine, which is prepared as follows:—

3 ounces of *fresh* white lac are dissolved in 1 pint of strong alcohol, and after filtering or decanting, as much water is added as it will bear without precipitating the lac; 1 ounce of good gelatine is soaked and dissolved in the pint of boiling water, and the lac solution is added with frequent stirring. If, at any stage of this operation, the gelatine is precipitated, a little

more hot water must be added. The pint of lac solution ought, however, to be emulsified in the gelatine solution.

To use the emulsion, it is warmed, and the paper immersed in or floated on it for three minutes. When dry, the coated surface is floated in the following for a couple of minutes:—

Ammonium chloride	...	...	...	10 grains
*Magnesium lactate	...	...	...	10 „

When dry, it is sensitized on a moderately strong bath (that given at page 127 will answer).

If more vigour in the resulting prints be required, it is floated on—

Citric acid	...	...	...	5 grains
White sugar	...	...	...	5 „

This last bath improves by use, probably by the accumulation of silver nitrate from the sensitized paper.

Any of the toning baths given at page 132 will answer, though Mr. Cooper recommends:—

Solution of gold tri-chloride (1 gr. to 1 dr. of water)	2 dr.
Pure precipitated chalk	...
Hot water	...
	...
	...
	10 ounces

2 dr. of sodium acetate are to be placed in the stock-bottle, and the above solution filtered on to it. This is made up to 20 ounces, and is fit for use in a few hours; but it improves by keeping.

In commencing to tone, place a few ounces of water in the dish, and add an equal quantity of the stock solution, and if the toning begins to flag a little, add more of it from time to time.

With the resin processes over-toning is to be carefully avoided.

FIXING THE PRINT.

The usual strength of the fixing bath is—

Sodium hyposulphite	...	...	...	4 ounces†
Water	...	...	...	1 pint

Between toning and fixing it is well to wash the prints slightly, in case there should be any trace of acidity in the liquid adher-

* Or ten minims of ammonium lactate.

† One ounce of sodium hyposulphite will fix with safety three sheets of paper.

ing to them. After taking them out of the toning bath they should be placed in a dish of water, face downwards, till a batch is ready for fixing.

It will be noticed that the toning action on the print continues during this washing, presumably by the solution of gold contained in the pores of the paper continuing to deposit. The addition of a small quantity of common salt has been found useful to stop this action. If this precaution be not taken, the prints first toned should be left redder than it is intended they should remain. The action can also be arrested by acidifying the water. This is dangerous, as the presence of acid in the fixing bath causes a speedy decomposition of the hyposulphite.

The prints should be immersed in the fixing bath for twelve or fifteen minutes,* and the solution should be kept in motion during the whole time of fixing, as for toning. Care should be taken to brush off all bubbles that may cling to their surfaces, as the cushion of air impedes the access of the liquid to the silver salt beneath.

When the prints are fixed they will appear colourless in the whites, and free from red patches in the dark portions.

In some establishments it has been found advantageous to add a drachm of ammonia to each pint of fixing solution. The ammonia aids the rapidity of fixing, and neutralizes any acid that inadvertently may find its way into the solution; it also attacks the size of the paper, dissolving it out from the paper in a great measure. This renders the subsequent washing more thorough, and is found, in most instances, to prevent "blistering," which is common with so many albumenized papers.

The prints should be withdrawn slowly from the bath—in order that all excess of the hyposulphite solution may be drawn from them by capillary attraction—and placed in a trough of water, where they should soak a quarter of an hour. They should then be removed, and placed in a stream of running water for twelve hours. If running water be not attainable, a good plan is to place the prints in a dish, changing the water every half hour for five or six changes, and sponging all the moisture out with a thoroughly washed sponge as far as possible after every second change. By this procedure the hyposulphite is very perfectly eliminated. Prints washed in this manner have remained unaltered in colour for the last fifteen years in the

* The thicker the paper the longer, the time of immersion.

writer's experience, having passed through climates dry and moist, and varying in temperature from 20° to 110° .

It is sometimes useful to test the water for sodium hyposulphite, after the last washing, in order to ascertain if its extraction is complete. Make the following test solution :—

Potassium permanganate	...	...	2 grains
Potassium carbonate	...	...	20 "
Water	...	...	1 quart

The addition of a few drops of this rose-coloured solution to a pint of water will yield a slightly pink tinge. If there be any trace of sodium hyposulphite present, the colour will be of a greenish hue.

If the permanganate be not at hand, the following well-known starch iodide test may be adopted :—

Take about two drachms of water and a small piece of starch about the size of a small pea, powder, and boil the starch in the water till the solution is quite clear; add one drop of a saturated solution of iodine in alcohol to this clear liquid. It will now become dark blue. (Of this solution drop two drops into two clean test-tubes, and fill up one with distilled water, and the other with the water to be tested; a faint blue colour should be perceptible in the first test-tube. In the second test-tube, should hyposulphite be present, this blue colour will have disappeared, the iodide of starch becoming colourless in its presence. The best mode of comparing the two waters is by placing a piece of white paper below the test-tubes, and looking at the paper through the length of the test-tube.

It frequently occurs that though sodium hyposulphite cannot be detected in the washing water, it may be present in the paper itself. The paper on which most prints are taken being sized with starch, if a *very* weak solution of iodine be applied with a brush across the *back* of a print, a blue mark will indicate the *absence* of the hyposulphite, iodide of starch being formed. Care must be taken that the iodine solution is *very* weak, otherwise a part of the iodine will first destroy the trace of the hyposulphite, and then the remainder will bring out the blue re-action.

The dishes used for *toning*, *sensitizing*, and *fixing* should be used for no other purpose than that to which they are originally allotted. A porcelain dish on which the glaze has cracked should be rejected for the sensitizing dish, and for the fixing

dish. In the first case, the porous porcelain absorbs a vast quantity of silver nitrate; and in the latter, of old fixing solution, which is *very* apt to cause yellow markings on the prints.

Tin dishes should be avoided in all cases. The tin corrodes and marks the pictures. Perforated zinc is often used for the bottoms of washing troughs. This also should be avoided, as after a time it becomes fouled, the sodium hyposulphite acting upon it, and the prints get stained where they touch it.

DEFECTS IN PRINTS.

Small white spots, with a black central pin-point, are often met with in prints. Dust on the paper during sensitizing will cause them, the grit forming a nucleus for a minute bubble. All paper should be thoroughly dusted before being floated on the sensitizing bath.

Grey, star-like spots arise from small particles of inorganic matter, such as ferric oxide, lime, &c., which are present in the paper. They become more apparent by decomposition during the printing operations. They may generally be discernible by examining the paper by transmitted light.

Bronze lines (straight) occur through a stoppage during floating the paper in the sensitizing solution. Should the lines be irregular, forming angles and curves, it is probable that a scum of silver oxide, &c., may be detected on the surface of the sensitizing solution. A strip of blotting-paper drawn across the bath will remove the cause of the defect.

Should the print appear marbled, it may be surmised that the sensitizing solution is weak, or that the paper has not been floated sufficiently. In some cases it may arise from imperfect albumenizing; but in ordinary commercial samples the cause can be easily traced.

Red marks on the shadows may appear during toning, and are very conspicuous after fixing. They generally arise from handling the paper with hot, moist fingers after sensitizing; greasy matter being deposited on the surface, prevents the toning bath acting properly on such parts.

Weak prints are generally caused by weak negatives. Such can be partially remedied by paying attention to the strength of the sensitizing bath (as shown in page 128), and by using washed paper.

Harsh prints are due to harsh negatives. They can generally

be remedied by paying attention to the mode of printing, also given at page 128. If the negative be under-exposed and wanting in detail, there is, however, no cure for this defect.

A red tone is due to insufficient toning; whilst a poor and blue tone is due to an excess of toning.

The whites may appear yellow from imperfect washing, imperfect toning, imperfect fixing, or from the use of old sensitized paper.

Should prints refuse to tone, either the gold has been exhausted, or else a trace of sodium hyposulphite has been carried into the toning bath by the fingers or other means. A trace of hyposulphite is much more injurious to the print than a fair quantity of it. Should the toning bath refuse to tone after the addition of gold, it may be presumed that it is contaminated by a trace of sodium hyposulphite.

A dark mottled appearance in the body of the paper indicates imperfect fixing, combined with the action of the light on the unaltered chloride during fixing. If the fixing bath be acid, the excess of acid combines with the sulphur, and forms hydrosulphuric acid, which will also cause the defect.

The cause of mealiness or "measles" in the print has been explained in page 122.

Maxims for Printing.

1. The print should have the highest lights *nearly* white, and the shadows verging on a bronzed colour before toning.
2. Place the prints, before toning, in the water, face downwards, and do not wash away too much of the free nitrate of silver (see exception, page 133).
3. The toning solution must be neutral or slightly alkaline, and not colder than 60°.
4. Tone the prints to purple or sepia, according as warm or brown prints are required.
5. Move the prints in both the toning and fixing solutions, repeatedly, taking care that no air-bubbles form on the surface.
6. Take care that the fixing bath is not acid.
7. Use fresh sodium hyposulphite solution for each batch of prints to be fixed.
8. Wash thoroughly *after* and *before* fixing.
9. Make a sensitizing bath of a strength likely to give the best results with the negatives to be printed.
10. Print in the shade, or direct sunshine, according to the density of the negative.

COLLODIO-CHLORIDE PAPER.

The collodio-chloride process was introduced by Mr. G. Wharton Simpson. Primarily, it was described for printing on glass or paper, and for such it is given here.

The collodio-chloride is formed as follows:—

*No. 1—Silver nitrate...	...	...	...	1 drachm
Distilled water	...	...	...	1 „
No. 2—Strontium chloride	...	...	...	64 grains
Alcohol	...	...	...	2 ounces
No. 3—Citric acid	...	...	...	64 grains
Alcohol	...	...	...	2 ounces

To every two ounces of plain collodion add thirty drops of No. 1, previously mixed with one drachm of alcohol; then add one drachm of No. 2, shaking well at the same time; lastly, half a drachm of No. 3 solution. In a quarter of an hour it is fit for use. There is sometimes a difficulty found (especially when applying the collodio-chloride to glass) due to the crystallization of the salts on the surface of the film. The writer has entirely overcome it by using the above proportions, substituting 72 grains of ammonium citrate for the citric acid, and then washing the emulsion thus formed in a similar manner as directed for the bromide emulsion (see page 87). It is, however, necessary to add a small quantity of silver nitrate after re-dissolving the collodion pellicle in the proper proportion of solvents; about 8 grains to the ounce of emulsion is the amount recommended. If, however, the paper or plate be immersed in a solution of—

Potassium nitrite	...	...	...	20 grains
Water	...	...	...	1 ounce

the silver may be entirely omitted, and a vigorous image will result. The reasons of the addition of the nitrite is the same as that given for adding it to washed paper (see page 130).

The above formulæ apply to printing on paper, or on glass, porcelain, &c.

The paper best adapted for the reception of the collodio-chloride is arrowroot paper. A paper rather larger than the size of print required is taken, the edges turned up for one-eighth of an inch all round to form a tray, leaving a small spout

* The formulæ are taken from the YEAR-BOOK OF PHOTOGRAPHY for 1871.

at one corner. This paper is then placed on a glass plate, and is coated in a dark room with the emulsified collodion, and allowed to dry. It may be found to increase the brilliancy of the resulting print to pin it on the inside of the lid of a large box, and to expose it to the fumes of a drachm of ammonia poured into a saucer, though this is unnecessary when the potassium nitrite is used.

The print is taken in the ordinary manner, and may be toned by any of the ordinary toning baths, the lime bath (No. 1, page 132) being the best, providing it be old.

The following toning bath, made in two separate solutions, gives rather inky tones :—

No. 1.—Ammonium sulphocyanide	...	1½ ounces
Sodium hyposulphite	...	45 grains
Sodium carbonate	...	15 "
Water	...	50 ounces
No. 2.—Gold trichloride	...	30 grains
Chalk	...	1 teaspoonful
Water	...	50 ounces

Equal quantities of these are taken and mixed, and the toning proceeds as usual. The prints ordinarily take from two to ten minutes to tone. If a longer time be required, add more gold till the desired effect is produced. This toning bath can only be used once.

FIXING BATH.

The fixing bath is composed as follows :—

Sodium hyposulphite	...	1 ounce
Water	...	30 ounces

The print should be immersed in this for about 8 minutes.

PRINTING WITH SALTS OF IRON AND URANIUM.

The basis on which these processes are founded is that the ferric and uranic salts are reduced to the ferrous and uranous state by the action of light. Thus ferric chloride throws off one atom of chlorine, and becomes ferrous chloride.

The most ready process for obtaining prints from a negative by an iron process is that originated by Sir John Herschel, in

which the double ferric citrate and ammonium citrate are the sensitive agents. To prepare this salt, precipitate ferrous sulphate (*after thorough boiling with nitric acid*) by ammonia, and wash the oxide by decantation. Next make a saturated solution of citric acid, and add it to the oxide till it is nearly all dissolved; but note how much citric acid solution has been employed. Take an equal quantity of this same solution, and neutralize it carefully with ammonia, testing with litmus paper, and mix the two solutions.

Dilute this solution to half the bulk, and, after filtering, float plain paper on it. When dried, it may be exposed beneath a negative in the sunlight for two or three minutes, or in good diffused light for a quarter of an hour.

These prints require development, which may be effected by immersing them in a solution of potassium ferri-cyanide, which will give blue prints. They are fixed by slightly acidulating the first wash water with hydrochloric acid, and then thoroughly washing in ordinary water.

A silver print may be obtained by floating the print, after exposure, on a dilute solution of silver, which will be partially reduced by the ferrous compound produced by the action of light, and then applying gallic acid and silver (see page 114) to intensify the image. In this case, it is well to fix with sodium hyposulphite, and to wash as usual.

A print may also be formed in metallic gold by brushing over the exposed paper a dilute and neutral solution of gold trichloride.

To fix these prints they should be immersed in water slightly acidified with hydrochloric acid, and be then thoroughly washed.

Positive Pictures from Positives.—To obtain positive pictures from a positive, a slight modification of the above must be made. Paper must be floated on—

Ferric chloride ...	...	...	...	50 grains
Oxalic acid ...	...	...	...	25 „
Water ...	...	...	...	1 ounce

It is then exposed beneath a positive (such as in engraving or tracing), and developed by immersing it in—

Potassium ferro-cyanide ...	...	...	80 grains
Water ...	...	...	1 ounce

The ferric salt combines with this to form prussian blue, leav-

ing white the portions unaltered by light. The print is fixed as above. This process is useful for copying tracings and prints which are on tolerably transparent paper.

To print with uranium the following sensitizing bath may be employed—

Uranic nitrate ...	...	...	...	80 grains
Water ...	...	...	...	1 ounce

The prints may be developed by the first three developing solutions given for developing the iron prints. With the first one we have a very brown print, with the next the greyish one due to the colour of deposited metallic silver, and with the last the purple tone due to metallic gold.

The Platinum Printing Process.—This process is the subject of a patent, and was described by Mr. Willis to the Photographic Society of Great Britain as follows:—

Ferric oxalate is very sensitive to light, and is reduced or converted into ferrous oxalate. Some four or five years ago Mr. Willis discovered that ferrous oxalate, when dissolved in a hot solution of potassic oxalate, instantly reduces the metal from chlorides and other salts of platinum.

Now, suppose a platinum salt, such as chloro-platinate of potassium, $K_2 Pt Cl_4$, is mixed with the ferric oxalate with which paper is coated, upon exposing such paper to light the ferric salt only will be affected, being changed into ferrous salt; but the particles of this ferrous salt will be in contact with the platinum salt. If now this insolated paper be floated on a hot solution of potassic oxalate, its ferrous image will be dissolved by the potassic oxalate, but at the moment of solution it will reduce, *in situ*, some or all of the platinum salt so intimately mixed with it, and the result is a picture in pure metallic platinum.

Until very recently no means had been discovered of getting down the platinum in a sufficiently fine state of division without the aid of a preliminary coating of silver salt; this difficulty has now, however, been overcome. By adding a platinum salt to the developer the metal is reduced in a very fine state of division.

The following materials are used:—

Plain paper, or paper having a slight additional sizing of some colloid.

1st. A solution of ferric oxalate, containing about 130 grains of the salt to each ounce of water.

2nd. A solution containing 30 grains of chloro-platinite of potassium and 3 grains of plumbic chloride to each ounce of water.

3rd. A solution containing in each fluid ounce 120 grains potassic oxalate and 7 grains chloro-platinite of potassium.

A sheet of the paper is now suitably fastened on a plane surface. Equal quantities of the ferric oxalate solution and of the chloro-platinite of potassium solution are mixed, and 2 fluid drachms of the mixture are evenly spread over the paper by means of a piece of flannel wound around a glass rod. The paper is now hung up to dry; as soon as all surface moisture has disappeared, the drying is finished before a fire or stove. The paper is now ready for exposure under a negative. This sensitized paper will keep perfectly good in a dry atmosphere, both before and after exposure, for more than a month.

The time of exposure may be determined by an actinometer, or by simple inspection—preferably by the former method. The length of exposure is about one-third of that required in ordinary silver printing.

The slightly visible image formed of ferrous oxalate is developed by floating the paper for a few seconds on a hot solution of No. 3. The brownish ferrous image is converted into a black one by the reduction of metallic platinum. The potassic oxalate dissolves the ferrous image, and the solution thus formed, before or at the moment of leaving the surface of the paper, reduces the platinum salt to the metallic state. The image is thus formed of metallic platinum, one of the most stable substances known to chemists, perfectly unalterable by any atmospheric influences, not oxidized in the air at any temperature, and not attacked by any single acid or alkali.

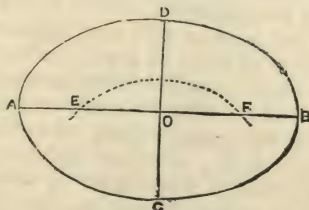
MOUNTING PRINTS.

When prints are taken from the drying line, they are found to be rolled up, and, it may be, in parts slightly cockled; in this state it is difficult to mount them. The method of *strok-ing* prints has been introduced to get rid of the defects. A flat piece of hard wood, about one foot long and one and a-half inch broad, and the thickness of a marquise scale, has its edges carefully rounded off. The print is seized by one corner in one hand and unrolled; the face of the print is brought in contact with a piece of plate-glass. The "stroker," held by the other hand, is brought with its rounded edge on to the back of the print near

the corner held by the first hand. Considerable pressure is brought upon the stoker, and the print is drawn through between it and the plate. The print is then seized by another corner, and similarly treated. By this means a gloss is put upon the print, and the creases and cockles are obliterated. The print is now ready for trimming.

It is well to have a square of glass with true edges cut to the size of the pictures. The prints should be trimmed upon a sheet of plate glass, a sharp penknife being used to cut them. A rough test for ascertaining if the opposite sides are equal is to bring them together and see if both corners coincide.

It may sometimes be found useful to cut out a print into an oval. The following method for tracing any ellipse may be employed:—On a thickish piece of clean paper draw a line AB, making it the *extreme* width of the oval required. Bisect it at O, and draw DOC at right angles to AB. Make OC equal to *half* the smallest diameter of the ellipse. With the centre C and the distance OB draw an arc of a circle, cutting AB in E and F.



Place the paper on a flat board, and at E and F fix two drawing pins. Take a piece of thread and knot it together in such a manner that half its length is equal to AF. Place the thread round the two pins at E and F, and stretch it out to tightness by the point of a lead pencil. Move the pencil guided by the cotton, taking care to keep it upright. The resulting figure will be an ellipse. Modifications of this figure may be made by making a second knot beyond the first knot, and placing the point of the pencil in the loop formed. When the figure has been traced in pencil on paper, it should be carefully cut out with a sharp penknife, and placed on the print which is to be trimmed into an oval. When so placed, a faint pencil line is run round on the print, and the cutting out proceeds either by scissors or penknife. Ovals, in sheet tin or brass of different sizes, are

supplied by the dealers in photographic apparatus. The little instrument called the photographic trimmer is excessively handy



for cutting out the prints when these shapes have been procured. The cutting-wheel is brought against the edge of the shape, and, being pivotted, follows the curves mechanically.

There are a variety of mounting solutions in common use, the most favourite being starch. This is prepared in the ordinary way, and is laid on the back of the print by a hog's-bristle brush. Starch is dangerous to use, unless perfectly *pure* and *fresh*. It is apt to become acid, destroying the print in contact with it.

To prepare gelatine for mounting, take half a wineglassful of gelatine, and cover it with cold water; when thoroughly swelled—which will be in about three-quarters of an hour—pour off any water that has not been absorbed, and fill up the wine-glass with boiling water. The gelatine will now be dissolved, and will remain fluid if the wine-glass be kept standing in warm water. This mounting medium is applied in the same way as the starch. Very thin glue is also occasionally employed, and answers well. In the market, at the present time, there are two or three made-up alcoholic mounting solutions, which answer admirably for small pictures, though when prints of 15 by 12 or over are to be mounted, it is rather difficult to give the back an even coating before the solution dries.

One great advantage of these solutions is that they do not cockle the mount, however thin it may be. Prints may be mounted on foolscap paper with the greatest ease, and they will be as flat as if mounted on the thickest cardboard. A solution suggested by Mr. G. Wharton Simpson is made as follows:—Take gelatine or fine shreds of glue, and swell them with the least possible quantity of water. Boil them with alcohol, keeping them in agitation with a stirring rod the whole time. Eighty grains of gelatine will take about two ounces of alcohol to render it of a fit consistency for mounting. When cool the solution will become gelatinous. It can be used for mounting by letting it stand in a pot of warm water.

Before applying the mounting solution, the places where the corners of the print will come on the card should be marked with

fine dots. The back of the print, having then been brushed over with the mounting solution, should be carefully placed on the mount, the corners coinciding with the dots. A piece of white blotting-paper should next be placed over the print, and the back of the print should be brought in close contact with the mount by rubbing the clenched hand over the blotting-paper. To obtain great evenness, a piece of white cream-laid paper may then be placed over the print, and the edge of an ivory rule or paper-knife be scraped briskly over it. This adds a brilliancy to the print, and prevents cockling in a great measure when starch or gelatine is used, all excess being squeezed out.

The print is ready for rolling after the mounting solution is well dried, into the details of which it is not necessary to enter. The rolling machine which takes the form of the ordinary copper-plate press answers every purpose. Finally, the surface of the mounted print may be waxed. There are various formulæ for the encaustic, the simplest being:—

White wax	...	...	...	...	1 ounce
Spirits of turpentine	...	...	...	...	1 ,,

the solution taking plainly by the aid of heat.

Mr. Valentine Blanchard uses white wax dissolved in benzole. This, he states, leaves a good coating of wax on the print, the benzole evaporating entirely.

M. Adam-Salomon's encaustic paste is made as follows:—

Pure virgin wax	...	...	...	500 grains
Gum elemi	...	...	...	10 ,,
Benzole	...	...	...	$\frac{1}{2}$ ounce
Essence of lavender	...	...	...	$\frac{3}{4}$,,
Oil of spike	...	...	...	1 drachm

The waxing solution may be taken up by a tuft of cotton-wool, and spread roughly over the surface of the print. A clean pad of cotton-wool is then used to rub it well in, till the surface assumes a bright gloss, and is free from all appearance of markings. For increasing the depth of shadow and general beauty of a print, waxing is of the greatest utility.

There are other means of giving what is sometimes called an *inartistic* gloss to the print, the simplest with which we are acquainted being to squeeze a damp print in contact with the surface of a freshly plain collodionized glass plate, and to allow

them to dry. The print is then stripped off, and the collodion film gives a brilliant surface to the finished print.

Recently, burnishers of a very excellent type have been introduced into the market. Burnishing gives extraordinary brilliancy to a print, and is easily executed with a proper machine.

PRINTING WITH DI-CHROMATES OF THE ALKALIES.

If gelatine be mixed with a solution of a dichromatic of an alkali, and dried in non-actinic light, it will be found that it is perfectly soluble in water. If, however, it be exposed to the action of light, it will be found to have become insoluble. On this rests the whole superstructure of permanent pigment printing, photo-lithography, heliotypy, papyrotypy, and such processes akin to them.

The chemistry of the process is rather involved in difficulties, on account of the organic changes that may take place in the gelatine. It will suffice to point out the main action that takes place, viz., that "gelatine, aided by light, reduces the chromic acid of the bichromate to a lower state of oxidation, and then enters into combination with a compound of chromic oxide produced by the mutual decomposition of the chromic acid and gelatine, being the formation of a leather-like substance,"* insoluble in hot water. The addition of various substances to the gelatinous compound has been found to aid this decomposition.

The quality of the gelatine is an important matter, and before taking into use it should be roughly tested by soaking 50 grains of it in 1 ounce of water for a few hours. The excess of water when drained off should be tested by blue litmus paper for acidity, and for sulphates by the addition of barium chloride. If there be no acidity nor sulphate present, the same amount of water as was drained from it should be added, and the beaker containing it placed in warm water of about 90°. This should dissolve the gelatine, and when cooled it should set and be nearly transparent. If the set gelatine liquefies at a temperature of not less than 80°, it may be used. The best basis of the colour-

* From a paper read before the Photographic Society, May 10th, 1870, by Mr. Swan.

ing matter is Indian ink, which can be softened by soaking in rain or distilled water, and then be rubbed down and filtered from the larger particles. The black colour thus obtained can be modified by the addition of alizarine, Vandyke brown, &c., but there are some colouring matters which render the gelatine insoluble, and are therefore to be avoided.

THE AUTOTYPE PROCESS.

The first process that is to be described is known as the "Autotype."

From the Autotype Company can be procured sheets and rolls of coloured gelatinized paper of every tint, and these are the foundation of all their permanent prints.

The carbon tissue, as it is termed, is tiresome to prepare on a small scale; hence it is better to procure it direct from the firm above indicated. They supply it ready sensitized, and it can be transmitted by post. When unsensitized it is necessary to float it on a solution of potassium dichromate and water—

Pure potassium dichromate	...	...	1 ounce
Water	...	...	20 ounces

The potassium dichromate should be nearly neutral, and contain no free acid. Should it contain acid, the tissue is liable to become insoluble. Free acid* may be neutralized by the addition of potash in solution till no extraordinary acid reaction is evident to blue litmus paper. A dish somewhat larger than the sheets of *tissue* (as the gelatinized paper is called) to be floated is used for floating. The solution should be at least a quarter of an inch in depth in the dish. The piece of pigmented paper is taken, and a quarter of an inch folded back at one end at right angles, and rolled up to a diameter of about two or three inches, gelatine surface outside. The turned-up end remains on the outside of the roll. The angle of the folded end is now dropped upon the solution, and the coil of paper is allowed to unfold itself, driving out all bubbles behind as its surface comes in contact with the solution.

The floating should last from two minutes in warm weather to three in cold.† The turned-up end should then be pinned by

* Potassium dichromate always shows a slightly acid reaction to test-paper.

† Should the temperature of the solution exceed 80° F., it must be reduced by adding a little pounded ice.

a couple of pins on a thin lath, and the sheet of tissue slowly withdrawn from the bath, and hung up to dry.

The drying of the tissue should take place in a room perfectly free from vapours, such as sulphuretted hydrogen, or those produced by the combustion of gas. If possible, a current of warm, dry air should be created through the drying room; in summer a large candle, or, better still, a gas jet placed in a chimney, will create sufficient draught, if the paper be dried near the fireplace. The quicker the paper dries, the better it will work, though the less sensitive it is to light.

It may happen that the photographer is out of reach of the Autotype Company, in which case he may desire to prepare the tissue for himself. The following proportions for the gelatine mixture are taken from Liesegang's "Manual of Carbon Printing."*

Water	...	...	...	...	1 ounce
Gelatine	...	...	...	120 to 150	grains
Soap ...	...	...	...	...	15 "
Sugar	...	...	...	...	21 "
Dry colouring matter...	...	...	...	4 to 8	"

The gelatine, sugar, and soap should be put into the water and allowed to stand for one hour, and then the colour is carefully ground up and added gradually, the gelatine having been first dissolved by the aid of heat. The mixture is then *well stirred* up, and finally filtered through muslin (see Helio-type Process). Manufacturers coat long bands of paper by passing it once through the mixture. Since this work is not intended for instruction to those who are commercially engaged in the preparation of tissue, but only for those who are learning photography, we have omitted the description of this method. The following method will be found suitable for preparing a small stock of tissue.

A glass plate is cleaned with nitric acid, next with potash (see Appendix, "Silvering Mirrors"), and finally rubbed with ox-gall whilst still wet with distilled water. After carefully levelling (see Helio-type Process) sufficient gelatine (about $2\frac{1}{2}$ ounces for a 12 by 10 sheet of paper) is poured on to the plate as in the Helio-type Process. After setting, a sheet of paper slightly damped is

* "Manual of Carbon Printing," by Dr. Liesegang, translated by R. Marston (Sampson Low, Marston, & Co.)

laid on the gelatine surface in such a way as to avoid air-bubbles. When the gelatine adheres to the paper the latter is raised and the gelatine adheres to it, the separation from the glass plate being helped by means of a penknife.

When quite dry, the paper is exposed under the negative in the ordinary manner, a "safe edge," as it is technically termed, being placed round it. The safe edge consists of a mask of brown or other non-actinic paper, externally larger than the negative, and internally slightly smaller, the negative being, as it were, framed by it. The pigmented paper must be slightly larger (say a quarter of an inch each way) than the size of the print required. If the print be examined during exposure, there will be no change in its appearance, owing to the pigments used to give it the necessary colour; consequently it is necessary to use an actinometer to time the exposure.

The original Autotype actinometer consists of a slip of albumenized paper* rendered sensitive by a standard silver solution. This becomes tinted or coloured by exposure to the light. The tint thus produced is compared with a standard one, *painted* on a strip of paper or tin. When about to be used, a small portion of the strip of paper is exposed to the light simultaneously with the print. When the paper has attained the colour of the painted standard, it is said to have had one tint. A fresh piece of paper is then exposed for another tint, and so on.

For a negative of ordinary density two tints will generally be found sufficient in the summer, and probably five in the winter; but experience must decide the time required for different negatives. Some five years ago, however, it came to the writer's notice that the length of exposure to actinic light necessary to produce a print by the autotype carbon process might be diminished by three-quarters, or even seven-eighths, by withdrawing the print from beneath the negative, and leaving it in the dark. The printing action once started continued gradually, and on development, after a lapse of several hours, the picture was found to be fully printed. In winter this curious continuing printing action was of special value, as it enabled from four to eight times the number of prints to be produced from a negative by giving only a quarter to an eighth of the right exposure, and then keeping them in a dark room. The writer also experimented with

* Other forms of actinometer are employed, which depend more on the principle of that employed for heliotypy.

certain non-actinic lights, and found the same action was maintained, but with greater rapidity. Hence hanging a partially exposed print up in a yellow lighted room was better than leaving it in the dark. When one quarter of the exposure was given, a print hung up in the dark was found to be properly printed in twelve hours; whilst if only one-eighth, it required sixteen hours.

The development of the tissue should be conducted in a room in which the light is weak or non-actinic. Close at hand, on a table, should be a dish containing water to a depth of an inch or more. To the bottom of this is sunk a finely-mulled flat zinc plate, at least one inch larger each way than the negative; the paper is now drawn, face downwards, under the water, till it nearly rests upon the zinc plate. It will be noticed that the paper at first tends to coil downwards, but gradually unrolls till it is perfectly flat, and if left longer that it would coil upwards. At the moment it has become flat, the zinc plate is seized by the hands, and raised horizontally out from the dish, the tissue resting upon it. It is then placed on a small low stool standing in another dish; one end of the paper is next pressed on to the zinc plate by one hand, and with the other the remaining portions are brought into contact with the "squeegee."* The first portion of the tissue is then brought into contact with the zinc in the same manner.

The zinc plates used are termed the "temporary supports" of the tissue. They are mulled in the ordinary manner with a muller and fine sand; the finer the grain given, the finer in detail will be the resulting pictures. Care should be taken that no scratches are on them, as every scratch is reproduced in the finished print. It was found by Mr. Johnson, who introduced this method of transferring the prints, that it was necessary to coat the plates with a fatty and resinous substance, of sufficient tenacity to keep the prints on them during development, but which should have less adherence to them than the film of gelatine has to the paper with which it is to be backed or mounted.

The following is the composition of the fatty body:—

* The squeegee consists of a flat piece of wood about two inches wide and three-sixteenths thick, into one edge of which is let a strip of india-rubber about half an inch wide, and projecting half that distance; the length of both the lath and india-rubber vary according to the size of the zinc plate. It is used by pressing the india-rubber edge against the paper, and passing it hastily over the surface.

Beeswax	...	...	...	3 drachms
Yellow resin*	...	...	...	3 "
Oil of turpentine	...	...	...	1 pint

These proportions are not absolute, as the composition of the beeswax varies. The resin must be added to the beeswax to such an amount that the gelatine film, even when dried in a hot room, will remain on the plate without cracking or peeling, but at the same time will leave the plate readily (when the applied transfer paper has become dried) without the application of any force.

With a piece of fine flannel, or cotton-wool, a small quantity of the above fatty body should be rubbed on to the plate. With another piece the excess of grease must be polished off, leaving but a *minute* layer of the compound on the surface. The zinc plate is then ready for the transference to it of the tissue.

The zinc plates are cleaned, after being used, by rubbing with flannel in boiling water. If this be not sufficient, a little turpentine or ammonia will cleanse them thoroughly, and render them fit for a fresh application of the fatty compound.

For some purposes it may be deemed advisable to give the prints a more highly polished appearance than that furnished by the use of a grained zinc plate. A glass plate prepared as follows answers the purpose:—

Beeswax in shreds	...	...	...	60 grains
Methylated ether	...	...	...	20 ounces

After resting twenty-four hours the solution is decanted. To each part of the clear fluid are then added five parts of benzoline. The plate is coated as with collodion, and dried. A coating of collodion is next given, and the surface thus prepared is used as a temporary support for the tissue.

Development is best effected by a trough or tin basin containing water, whose temperature can be maintained at 100° F. by aid of a gas jet or a spirit lamp. After the pigmented paper has been pressed into contact by the squeegee with the zinc plate, it should be laid aside for a couple of minutes, to allow the gelatine to swell. By the swelling of the gelatine a partial vacuum is created between it and the zinc plate, and the pressure of the air outside prevents it from peeling or stripping off. The zinc plate,

* The resin causes the adherence of the film to the plate, whilst the beeswax diminishes that adherence to the limits above stated.

with the adhering paper, is next placed horizontally in the trough for a minute, when it will be found that the paper can be peeled off, leaving the gelatine pigment on the zinc plate. The plate is now moved vertically in the water, or the water dashed over it with the hand; and gradually those parts of the gelatine which have been unacted upon by light will dissolve away, leaving the picture developed, with its half tones and deep shadows in perfect gradation. When the water flows from off the plate quite free from colouring matter it should be withdrawn, and then placed for a few seconds in alum and water (a dessert spoonful to a couple of gallons will suffice). This renders the remaining gelatine perfectly insoluble. Should a picture be only slightly under-exposed, plunging the plate into the alum and water, at the stage required, will stop development and give a passable print. If a picture be slightly over-exposed, water heated to 130° will often reduce its depth sufficiently. The plate, with the picture on it, should lastly be well washed under the tap to rid it of any traces of alum, and then be set up in a rack to dry.

It may seem curious to some that the pigmented gelatine should have to be transferred from paper to zinc plates to be developed, or, in other words, that development takes place from the back of the gelatine. A little thought will clear up the mystery. The light acts upon the pigment according to the actinism and *time* of exposure. A ray of light can only penetrate to do work to depths varying with its intensity (the variation is not a simple proportion, but much more complicated) and the amount of "work" done by it is in a ratio to the time of exposure.

The light passing through a negative at different parts varies in intensity. Thus it is evident that the insoluble part is at the surface, whilst the soluble is nearest the paper. Now, supposing it were attempted to develop the picture on the paper itself, it would be found that *nearly* all the *surface* of the pigment had become insoluble, and that, consequently, this leather-like substance would prevent the dissolution of the underneath portions, which were still soluble.

The best exposure for the paper is evidently when the light has penetrated in the deepest shadows just to the surface of the paper, whilst the densest parts of the negative have not allowed the passage of *any* light. It will be seen from this that a negative should possess similarly good qualities as if to be used in silver printing.

The print on the zinc plate will be found to be reversed. This is as it should be, as in the re-transfer it will be found to be in its proper position. The transfer paper is coated with a preparation of insoluble gelatine. Fifty grains of gelatine are dissolved in one ounce of water, and three-quarters drachm of a saturated solution of chrome alum are added to it immediately before use. A sheet of paper is coated in exactly the same way as that described for making tissue. The re-transfer on to paper is effected in a similar manner to the transfer of the pigmented paper to the zinc. The paper is plunged into water of a temperature of about 170° , where it remains till it becomes slimy to the touch. The plate bearing the dried picture is now dipped into cold water, and carries as much as possible away with it in a horizontal position on to the stool already mentioned. The transfer paper is then placed, prepared side downwards, upon the cushion of water, and is "squeegeed" into close contact with the picture as before. It is then allowed to dry spontaneously (in the sun, if possible), after which it will be found to leave the plate readily, bearing with it the picture on its surface. If dried by the sun it will coil off the plate of its own accord. If the paper be too hastily dried by the fire it will buckle and become cockled, and can only be flattened with difficulty.

If a matt surface be required, the print may be finished by rubbing with cotton-wool holding a little turpentine. A brilliant surface can be given by using an encaustic paste as for silver prints:—

White wax	...	...	...	...	1 ounce
Benzole	...	...	...	...	1 "

dissolved by the aid of heat ;

Or—

White wax	...	...	...	...	1 ounce
Oil of turpentine	...	...	...	...	1 "

dissolved also by the aid of heat.

For printing portraits a glass plate may be used in lieu of the zinc. The surface should be rubbed over with the waxing compound. Great care is requisite that the resulting surface is free from lines, as it should be remembered that every line on the surface of the plate will be exactly reproduced in the print. The glass may also be coated with a film of plain collodion (which should be *perfectly* transparent when dry), and after

varnishing round the edges the film may be used for the transfer. When re-transferred on to paper the collodion is detached, and the surface of the print is brilliantly glazed. It is advisable sometimes to rub the plate once, before applying the collodion, with a little white wax dissolved in ether. This facilitates the film leaving it. Mr. Johnson likewise coats the glass plate with water varnish, prepared as given for heliotype.

Mr. Baden Pritchard dries the picture after re-transferring by placing the zinc plate on a wide ring over a gas-burner. His observations led him to think that there is no deterioration in the print from this method. The danger to be apprehended is a separation of the film at the junction of the high lights with the shadows.

Mr. Sawyer, of the Autotype Company, has introduced a flexible temporary support, as a substitute for the zinc plate. It is made with a preparation of gelatine, and certain substances added to cause it to be insoluble and impermeable. The advantage claimed for it is that it expands with the tissue, eliminating the chance of a certain kind of blurring which has often been noticeable in the gelatine prints. The results obtained by its employment demonstrate the correctness of the claim. Another point in its favour is that the surface is less granular than with zinc, and the print is therefore more delicate.

The following is a description of the manufacture of the flexible support, taken from a paper read before the Photographic Society of Great Britain:—

“A solution of gelatine is made of variable strength, according to the quality of surface desired in the finished print. For a print to have a dead or matt surface, I employ about a 5 per cent. solution; for a more highly glazed surface, about $7\frac{1}{2}$ per cent.; and for a surface equal to highly glazed albumenized paper, a 10 per cent. solution. Paper wound on a reel, so as to be in a long length, is coated upon a carbon tissue-making machine with these solutions, and, when dry, is cut into sheets, and subjected to many tons' pressure in a hydraulic press. The solution of lac is made by dissolving one pound of button or bleached lac in five quarts of water in which have been dissolved four ounces of borax and one ounce of soda. This is put in what is called a digester, and heated until the lac is dissolved. The solution is then filtered, and, when cold, is ready for use. The gelatinized paper is floated on this solution in a shallow bath or tray, hung up to dry, and then finally rolled between metal plates

in a rolling press. Each sheet is rubbed over with a little of a solution made by dissolving resin in turpentine, and adding thereto a few grains of wax."

SINGLE TRANSFER PRINTS.

There is another method of producing carbon prints without transferring them to zinc, viz., by transferring them direct to the paper on which they should finally rest. In order to employ this method it is necessary to obtain a reversed negative. The transfer paper, prepared somewhat similarly to the retransfer paper used in the autotype process, is soaked in very hot water, and, after the carbon tissue has been passed through cold water, the two surfaces are brought together by the squeegee or by pressure. The two papers are then immersed in warm water of about 100°, and the backing to the pigmented paper stripped off. The development of the positive takes place as usual, and the paper bearing the print is hung up to dry, when it is ready for mounting and finishing. Single transfer paper may be prepared by soaking white sized paper in water varnish (see Heliotype Process).

Single transfer gives more delicate results than the double, no grain being present to mar the half-tones. The drawback to the process is the necessity of having a reversed negative.

THE POWDER PROCESS.

Under the head of printing processes comes what is usually known as the powder process. On the Continent it has been used with very good effect for the production of prints on paper, though in England its more familiar application is the reproduction of negatives or transparencies on glass. The rationale of the process is as follows :—

When a tacky body of an organic nature is brought in contact with potassium dichromate, and is allowed to dry as far as possible, and then exposed to light, it will be found that owing to the oxidation of that body by the chromic acid the tackiness will disappear in exact proportion to the intensity of the light acting on it. If a glass plate be coated with such a preparation, and be placed beneath a half-tone negative, the densities of the different portions of the negative will be represented by different stages of tackiness. A fine powder sprinkled over the exposed surface will adhere to the tacky portions in the ratio of the tackiness. Hence

a picture will be built up which will be a counterpart of the negative, only reversed. From this it will be manifest that in order to obtain a positive picture a reversed positive must be employed; though a line engraving, for instance, may be directly copied by this method by allowing the back of the engraving to be in contact with the sensitive surface.

The following are the formulæ that have proved, in our hands, most successful:—

(*Obernetter's Formula.*)

Dextrine	...	...	...	...	1 drachm
White sugar	.	...	...	...	1½ drachms
Ammonium dichromate		...	...	...	½ drachm
Glycerine	...	...	...	...	2 to 8 drops
Water...	...	...	...	...	3 ounces

Or,—

(*Woodbury's Formula.*)

Gum arabic	...	...	...	...	1 drachm
Glucose	...	...	...	...	¾ "
Glycerine	...	...	...	...	10 drops
Potassium dichromate		...	...	...	30 grains
Water	...	...	...	...	2 ounces

Whichever formula is employed, the solution should be filtered whilst warm, and be kept in a glass-stoppered* bottle.

A glass plate is next cleaned, and, if thought desirable, coated with a thin film of porous collodion, allowed to set, and then washed under a stream of water till all greasiness due to the solvents has disappeared. When drained, sufficient of No. 1 or 2 is taken in a clean glass measure, and allowed to flow over the surface two or three times. After pouring off the excess of fluid the plate is dried at about 150° F., or gently over a Bunsen burner or Argand lamp, &c. Whilst still warm, and before the surface has had time to re-absorb moisture, the plate is placed in contact with the transparency or negative from which it is desired to obtain a copy reversed as regards left and right, and placed in sunlight for two or three minutes, or in bright diffused light for ten or fifteen minutes. On removal from the printing-frame a faint image will be apparent, should the printing have proceeded far enough. The film is now exposed to the air in order that it

* A cork should not be used, as any extraneous organic matter is fatal to good results.

may imbibe moisture, and plumbago* is applied with a large flat brush. The lights or shades are now represented by the graphite according as a negative or transparency has been superimposed.

When the image has been fully developed, the superfluous powder is gently dusted away, and the film coated with tough collodion, that given for transferring films answering well. When well set, the plate is placed in water to allow the soluble gum and dichromate to dissolve out; and, if desired, the film may be detached from it by cutting round the edges with a sharp knife, and treating it as shown at page 118. The film thus detached may be made to adhere to any support required, such as paper or glass, by giving it a thin preliminary coating of gelatine.

The application of this process to paper can be now understood. In practice it is found advantageous to give it a good smooth sizing of gelatine previous to coating with the above. Ordinary albumenized paper, the albumen of which has been coagulated by heat and afterwards washed, may be substituted.

PHOTO-MECHANICAL PRINTING.

ALL photo-mechanical printing processes for the production of half-tone (with the exception of the Woodburytype process, to be described) are based on the same principle as the carbon or autotype process; viz., the insolubility in water (either hot or cold) of gelatine impregnated with a dichromate of an alkali, after exposure in a dry state to the action of light. Not only is insolubility produced, but also an inability to swell through the absorption of water. There is one other method of producing insolubility in gelatine, that does not prevent the absorption of water, viz., the addition to it of chrome alum, tannin, mercurous chloride, and various resins. These render the gelatine tough, and capable of withstanding a large amount of wear and tear.

Now if a layer of gelatine to which has been added potassium

* The plumbago should be of the finest description; that used by electrotypers answers better than any other we have tried.

dichromate and (say) chrome alum be exposed to light under a negative, and subsequently immersed in cold water, a little reflection will show that it is *all* insoluble in water; that where light has acted, there it will refuse to swell by the absorption of water; that where light has not acted, there it will absorb water. If a roller holding greasy ink be passed over the surface, the ink will be repelled from all the swelled portions, whilst it will adhere only to those parts on which light has acted. If a piece of paper be pressed down on such an inked-in surface, it is manifest that we shall obtain a positive print on its removal. With half-tone subjects the ink will only take in exact proportion to the time for, and intensity with, which the light has acted on the gelatine surface. It is also manifest that if a gelatine film be treated as described in the autotype process (page 154), that it will form a relief from which a mould may be taken.

WOODBURYTYPE PROCESS.

Mr. Walter Woodbury has successfully worked out a process of producing prints which may be classed under the head of photo-mechanical processes. For amateurs it would be difficult to undertake, owing to the apparatus that is necessary. The following is an outline of it. A film of sensitive gelatine is placed beneath a negative and exposed to light issuing from a fixed point, such as the electric light, or to sunlight, the negatives being always in the same position to the rays. This may be effected by a mirror, or by constantly moving the negative into position. Sky-light may be used, supposing the light be admitted down a tube, all side light being thus shut off. The gelatine film, when fully exposed, is developed by washing away the soluble portion, and the picture is now in relief, the highest lights being represented by the lowest relief. When dried, the gelatine print is placed on a soft metal plate, and driven into it by means of immense pressure, an hydraulic press being employed for the purpose.

An impression from the gelatine metal can also be taken by means of fusible alloy, as shown recently by Mr. Bolas. In this case, heat is applied to the top surface of the alloy, whilst cooling, in order that any contraction may take place away from the gelatine surface, by allowing the alloy in contact with it to cool first.

The metal sheet now becomes a mould, and is placed in a position on a metal table which forms part of the Woodbury-type process. Beneath the lid is a perfectly flat glass plate, which is so adjusted mechanically that it makes actual contact with the metal mould. A solution of gelatine in a hot condition, containing pigments or dyes, is run into this last; a piece of homogeneous and specially prepared paper is placed over it, and the lid shut down. The pressure causes all the superfluous gelatine to exude, whilst that in the mould adheres to the paper. When set, this is lifted off, and a picture appears in relief, the lights and shades being formed by varying thicknesses of gelatine. An immersion in a weak solution of alum causes the gelatine to become insoluble, and the picture, when dried, is ready for trimming and mounting. It will be noticed that, like the Autotype process, the print is dependent for its shade on the transparency of the pigment. Hence, the more transparent the colour employed, the better the half-tones are likely to be.

The pictures produced by this process are now well-known to most people, illustrations of cheap periodicals being frequently executed by it. They are beautiful and delicate, and, as far as at present known, permanent. The greatest drawback to Woodburytype is the difficulty experienced in obtaining pure white for any large surface, as in the skies of landscapes.

THE HELIOTYPE PROCESS.

In the heliotype process a film of gelatine is prepared on a glass plate, from which it is stripped when dry, and printed in the ordinary manner under the negative. The proper preparation of the film is of the highest importance, and unless properly performed, the resulting prints will be imperfect.

The glass plate should be perfectly flat, and finely ground* on one side. To prepare it, the ground side is waxed with a waxing solution of white wax dissolved in ether. This is applied plentifully to the plate with a soft rag or cotton wool, and rubbed well in. As much as possible is then removed with

* The polished surface of the glass may be employed by coating it with plain collodion containing equal parts of ether and alcohol, and about seven grains of pyroxyline, giving a horny film; or by a solution of india-rubber in benzole.

a little ether or spirits of wine, till the surface presents an even and almost polished appearance. When required for use, the waxed surface of the plate is levelled by means of a spirit-level, little wedges of wood being a convenient means of effecting it.

The following formula may be used in the preparation of the "skins" of gelatine for plates 22 by 16 :—

No. 1.—Gelatine	...	...	...	1½ ounces
Glycerine	...	...	...	1 drachm
Water	...	...	...	12 ounces

The gelatine which answers well, and is cheap, is Nelson's No. 3 Flake. It should be allowed to swell in the water, and, when thoroughly swollen, should be melted over boiling water, and then the glycerine added. The temperature of the gelatine should not rise above 115° F., and the solution should be stirred till a perfectly even fluid is produced.

The sensitizing solution is made as follows :—

	For Summer.	For Winter.
Potassium dichromate of potash	22 grains	30 to 40 grains
Chrome alum	15 „	15 to 7 „
Water	12 drachms	12 drachms

This quantity, after heating to 100° F., is added to the prepared gelatine solution immediately before use; in fact, it should be added in the vessel from which the plate is to be coated, and stirred well, to form a perfect mixture. A piece of muslin is tied over the top of the vessel, and the gelatine allowed to strain through it on to the levelled plate. The surface having been covered, and the gelatine allowed to set, the plate can be placed away from all dust in a drying room through which a current of air of about 75° is passing. The plate gradually dries after twenty-four to forty-eight hours. It will keep sensitive on the plate for a week or more. The drying-room should be glazed with deep orange glass, and be kept nearly dark. Ventilation is a *sine qua non*.

Another formula is appended, which has the advantage of giving an opaque white film :—

No. 2.—Gelatine	...	...	...	2 ounces
Glycerine	...	...	...	3 drachms
Water	...	...	...	9 ounces

This is prepared as before, but, just before use, and before adding

the sensitizer, five ounces of skimmed milk (which has been warmed, to cause the cream to rise) are stirred up with the solution. The sensitiser is then added as before:—

	For Summer.	For Winter.
Potassium dichromate	22 grains	30 grains
Chrome alum	7½ "	5 "
Water	12 drachms	12 drachms

When dry the skins are stripped from the glass plate, the edges being raised by a penknife. It is best to allow them to stay for half an hour in a place where the temperature and moisture are similar to that to which they will be subjected during exposure. This will prevent any danger to the negative in the printing-frame. The skin is next placed, with the surface which was not in contact with the plate uppermost, on a board on which has been nailed black velvet. Two small strips of the skin are cut from its edge, and placed one over the other in an ordinary printing-frame, with an opaque mask over them, in which is cut a lozenge-shaped hole. This is exposed to the light with the skin. When the image of the hole is seen well defined on the nethermost strip of gelatine, the skin is withdrawn, and its surface which was in contact with the glass placed in contact with a *reversed* negative in a printing-frame. (It is advisable that all the skin excepting that under the negative should be masked, to prevent the light acting on it.)

One of the ordinary actinometers, prepared

3	4	5	6	7	8	9	10	11	12
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with yellow oiled-silk, is now brought into requisition. In the figure each number denotes the number of thicknesses of the silk; hence, when on a strip of sensitive gelatine 6 is seen, the light has penetrated through six thicknesses; when 7, through seven thicknesses, and so on. A half-tone negative of ordinary density requires the number 10 to be read on a piece of the sensitive gelatine placed beneath it; a clear line subject, not more than 6 or 7. Of course the actinometer is exposed in the same light as the skin.* When a negative is weak, it may only be half printed, and the continuing action (see page 151) allowed to

* A small carte-de-visite pressure-frame is convenient for holding the actinometer.

act for twelve or twenty-four hours, when a more brilliant result will follow. In this case the preliminary sunning of the skin should be lessened, for obvious reasons.

Preparing the Transfer Plate.—A smooth metal plate of slightly larger dimensions than the skin (by preference pewter or nickelled steel) is coated with a solution of india-rubber in benzole, of the consistency of thick collodion (ordinary rectified lamp benzine answers ever purpose); this is allowed to dry. The skin is then placed in water, with the prepared plate beneath, for two to three seconds, and both are withdrawn, leaving a layer of water between the sunned side of skin and the coated surface of the plate.

A large squeegee is next brought to bear, and the two surfaces brought into close contact, as in the double transfer carbon process (page 152). If any dust be between the two surfaces, there is great danger of blistering. When squeegeed down, the edges are brushed round with india-rubber solution, to prevent the water penetrating underneath, and, when nearly set, the plate is immersed in water for periods varying from ten minutes to one hour.* When all the dichromate is washed out, the surface of the skin is wiped dry, and is then ready for printing.† Blisters having their origin in dust or bubbles in the film can generally be forced out by applying the flat part of the hand, and squeezing them out to edge.

Printing from the Gelatine Picture.—The plate is now laid on the bed of a printing press, and small strips of paper are pasted with india-rubber over the edges of the skin on to the plate. A piece of bibulous paper is placed on the skin, and a good hard pressure brought to bear; this squeezes out most of the superfluous water, and leaves the plate ready for inking. Best lithographic chalk ink‡ should have been prepared with green oil, and be of the consistency of soft wax. The gelatine or india-rubber roller should be coated with this ink by rolling on a stone slab or slate. When coated, the roller is applied, evenly and smoothly, to the plate. Those parts acted upon by light will take the ink, whilst all others will repel it. If the picture be a

* For a skin prepared according to No. 2 formula, ten minutes are sufficient.

† Should a collodionized or india-rubber surface have been used, care must be taken that all the collodion or india-rubber is detached before printing. These polished surfaces have great advantage, having no grain.

‡ All inks should be very finely mulled.

half-tone one, a thinner ink of any colour made up with oil or Russian tallow may be used on another roller. This roller will not rob the plate of the first, on account of the thinness of the second ink, but will support detail in the high lights. Paper is now placed on skin, and, with a moderate pressure, a proof is pulled. Should white margins be apparent round the blackest shadows, or if the relief of the plate be too great, it is a sign that the surface requires "smashing down." This is done by placing bibulous or enamelled paper on the skin, and bringing down the platen of the press with a great pressure. This gradually diminishes the relief. More ink is applied, and proofs are pulled till satisfactory results are obtained. The surface of the skin between each proof pulled should be slightly damped with a sponge, and the excess of moisture got rid of* by the squeegee and blotting-paper. This keeps the whites clean as in lithography, and gives pluck to the resulting picture. Should the whole of the picture be too deeply printed, a little dilute ammonia (one part to four parts of water) may be sponged over the surface till the over-printing is no longer visible. In order to keep clean margins to the prints, a mask is cut of the shape required. The mask paper is prepared as follows:—Stout bank post is laid flat on a board, and boiled linseed oil is brushed over it; or similar paper may be coated with a wash of india-rubber dissolved in benzole. It is hung up by clips to dry, and is then ready for use. The mask, of course, is turned back between each inking-in of the picture.

Paper.—Any kind of paper may be used with "milk" skins. Enamelled paper answers best with the ordinary ones, and is prepared with "mountain snow" and gelatine. Of ordinary paper, that answers best which is found most adhesive when the tip of the tongue is applied to its surface.

Varnishing Prints.—If thought necessary, the prints may be varnished, after pulling, by a water varnish. This is made by dissolving shellac in boiling water to which a little ammonia has been added. As the shellac dissolves, more is added, stirring the solution the whole time. From time to time more ammonia and shellac must be added, till the varnish, on drying, leaves a brilliant surface. The varnish is filtered, and applied to the print with a flat brush.

* This should be done as quickly as possible, as, if not, the film is apt to become unequally damped, and give an unequally printed proof.

Preparing the Gelatine Rollers.—The rollers are made of a solution of gelatine to which glycerine and castor oil are added. They are moulded in a cylindrical mould, on perforated wooden rods, similarly to the manner of preparing ordinary printing rollers. A roller for a first ink is coated with gold size and the fluff of blotting-paper; a second ink roller remains with the gelatine surface to take up the ink. India-rubber rollers can also be obtained, which answer well. The great secret of producing a good heliotype is to have first-rate rollers at command.

Failures.—The usual source of failure is the skins, in washing, when not kept sufficiently free from dust, and in which air-bubbles are to be seen. In winter, blisters will appear from the above causes, as well as from too low a temperature of the water. The washing water should never be below 60°. If a skin be over-sunned, or be kept too long after sunning, a scum of ink will invariably be apparent on the high light. If a picture be over-printed under the negative, it may often be corrected by the judicious application of ammonia, as given above. If it be under-printed, thinner inks may be tried; but it is better to print a fresh skin than to waste time over experiment. Imperfections in the prints often arise from the imperfect use of the squeegee and blotting-paper, and from an uneven coating of the rollers with ink.

CAPTAIN WATERHOUSE'S PHOTO-MECHANICAL PROCESS.

All other kinds of photo-mechanical processes are, it is believed, those by which the gelatine film is printed from without removal from the glass plate. Captain Waterhouse's *modus operandi* is here given, as it is simple, and has proved most effective.

The negative must in all cases be reversed as for the heliotype process.* Plate glass three-eighths of an inch in thickness is used; it is ground on one side. When required for use, it is carefully cleaned and levelled in the ordinary manner. (Small wedges of hard wood answer well for this.) The gelatine solution, made as follows, is poured on the plate:—

* Captain Waterhouse recommends, in some cases, that the film should be separated from the plate. Close contact is secured by this method.

No. 1.—Gelatine	...	...	...	...	1 ounce
Sugar	...	...	...	...	1 drachm
Distilled water	...	...	...	...	6 ounces

The gelatine must be allowed to swell, and be then dissolved.

No. 2.—Honey soap*	...	...	...	...	30 grains
Distilled water	...	...	...	...	1 ounce

No. 3.—Tannin	...	...	...	...	10 grains
Distilled water	...	...	...	...	1 ounce

The above quantities suffice for two square feet of plate.

When No. 1 is ready, Nos. 2 and 3 are mixed together hot, and poured gradually, with constant stirring, in No. 1.

The whole is then strained through two thicknesses of coarse cotton cloth, and poured evenly over the plates. (It is as well to let a very little run over the sides, as it secures adhesion of the gelatine to the surface.) Bubbles are broken by the point of a penknife. The plates are then covered over with a light paper cover, to prevent dust falling on them. They will set in this country in about ten minutes' time, when they should be turned over and allowed to dry, face downwards, being supported on blocks of wood at the corners. Drying may also be carried on as for the heliotype process. When they are dry, they are ready for sensitizing; this is done by immersing them in—

Potassium dichromate	...	...	...	...	1 part
Water	...	...	...	...	20 parts

for about five minutes, when they are re-dried. When dry, any deposit at the back of the plate, and inequalities at the corners, are removed, and the plate is ready for exposure to light.

“This operation is performed in a pressure-frame in the same way as for ordinary photographs. It is advisable, however, to secure clean margins by shielding the borders of the negative by means of a mask cut out in yellow or brown paper, which should well overlap the edges of the printing plates. The mask is laid on the glass of the pressure-frame, then the negative in its proper position (should this be a transferred film, it is advisable to place a glass plate between it and the mask, in

* Calvert's medical carbolic soap answers well, and prevents decomposition of the film.

order to secure the most perfect contact); the sensitive plate is then rubbed over with a little powdered soapstone, to prevent its adhesion to the negative, and adjusted in its place over the negative, covered with a sheet of black velvet or brown paper, over which a thick glass plate is laid, and, if necessary, a few sheets of thick paper to give a good strong pressure, when the bars are shut down. The thick plate of glass has been found to give much sharper and more even contact than the usual backboard.

“The amount of exposure to light varies from about ten minutes in the sun for a clear line subject to from twenty-five to fifty minutes for a subject in half-tones, according to the subject and intensity of the light; but, as it is impossible to judge of the progress of the printing by inspection, it is necessary to use an actinometer as a guide to the exposure (see page 163).

“When the exposure to light is considered sufficient, the negative and mask are removed, and the *back* of the sensitive plate is then exposed to light for about five or ten minutes, to thoroughly harden the gelatine, and prevent it from swelling too much in the after processes. It is as well to carry on this second exposure under a piece of ground glass; otherwise, if there should be any scratches on the back of the sensitive plate, or on the glass of the pressure-frame, they will show as white lines on the print; after this the plate is taken out of the frame; a little tallow is rubbed round the edges to prevent water getting underneath and stripping the film; it is then plunged in water and thoroughly washed till all traces of bichromate have been removed, and is ready for printing.

“*The Printing.*—The plates may be printed in the lithographic press, and then require to be fixed on a level stone with plaster of Paris. It has been found, however, more convenient, and in other respects better, to print them with vertical pressure in the ordinary Albion press; and in order to prevent their being broken, the bed of the press is fitted with two or three thicknesses of kamptulicon, besides a sheet of vulcanized india-rubber on which the plate rests. It is also desirable to place a sheet of white paper over the bedding, in order to enable the state of the plate, when it is being inked up, to be better seen.

“The plate, having been well soaked in water, is laid on the press, and, after having been wiped, to remove the excess of

moisture, is inked in, if a line subject, with an ordinary lithographic roller charged with an ink composed of lithographic chalk ink thinned with a little olive oil, followed by a rolling with a smooth roller to clean away the superfluous ink; a mask of the required size is laid on the plate, over this comes the printing paper covered with a piece of soft felt to drive the paper well into the hollows of the plate, the tympan is lowered, and the impression pulled in the ordinary way. The plate is then damped, and the work goes on in the same manner without difficulty.

"For printing in half-tones, however, the process is somewhat different, and to obtain uniformly successful results requires considerable skill and experience. As far as we have gone the following procedure has given the best results.

"The plate is first inked-in by means of a small leather hand-roller charged with stiff ink (rendered stiffer, if necessary, by the addition of a little Canada balsam), which takes only on the deeper shadows; the half-tones are then brought out by rolling in with a smooth lithographic roller charged with a lighter and softer ink. Rollers composed of glue, treacle, soap, and catechu have been found useful in certain cases for inking-in the plates, but, on the whole, the lithographic rollers are preferred. The impressions are best when printed on enamelled paper, but a smooth glazed printing paper also seems to answer well.

"Before putting away the plates after printing, they are washed with turpentine, followed by a very weak solution of caustic potash, to remove all traces of the greasy ink: they may also be treated after this with a mixture of gum and glycerine with advantage.

"*Corrections.*—A point which seems likely to greatly interfere with the extended use of the process was the difficulty of making corrections on the plates. I am glad to say that some experiments lately tried have shown that it is practicable both to insert and to take out or clear up details on the gelatine films.

"The insertion of details may be accomplished by two or three methods. The first is by writing in the required additions on the dry plate with a pen or fine brush, using an ink composed of bichromate of potash, used alone, or slightly coloured with Indian ink or indigo. After the additions are completed, the plate is exposed to the light for ten minutes or a quarter of

an hour, till the bichromate is thoroughly reduced, and may then be washed and printed as usual. In some cases, the same object may conveniently be accomplished by brushing over the part with solution of bichromate of potash, allowing it to dry, and then printing in the required details from another negative.

"Experiments have shown that details may be taken out by the aid of a solution of caustic potash or cyanide of potassium; and should a plate print dirty, it may be cleaned up and greatly improved by the use of a weaker solution of the latter substance.

"It often happens that the plates show too much relief in the lights, and that the ink will not take readily on the shadows or lines represented by the deepest hollows. This relief may be reduced by brushing the plate over with dilute nitric acid, one-sixth or weaker. The plate is then washed, and on inking-in the ink will take readily in the lines or hollows."

PHOTO-LITHOGRAPHY AND ZINCOGRAPHY.

PHOTO-LITHOGRAPHY is an important branch of photography where the rapid copying and multiplying of line subjects is in question, and requires much care and dexterity to carry out. It is rarely to be found that the process is worked satisfactorily by a beginner, but that constant practice will render it easy.

The part that is played by photography in photo-lithography is the obtaining of a print* from a negative in greasy ink which may be laid down upon the ordinary lithographic stone or a zinc plate. The principles of the process are the same as those laid down at page 148.

SOUTHAMPTON PLAN FOR PREPARING TRANSFERS.

Make the following mixture:—

Potassium dichromate ...	...	...	2 ounces
Nelson's fine-cut gelatine	...	...	3 „
Water ...	...	...	50 „

The dichromate is dissolved in ten ounces of water, and

* Called a transfer.

added to the forty in which the gelatine, after proper soaking, has been previously dissolved by the aid of heat. Good bank-post paper (very grainless) of a medium thickness is selected, and if this cannot be obtained, ordinary thin paper may be substituted, and cut into sheets a little bigger than the negative to be printed from. The solution is strained and poured into a dish through flannel.

The temperature is kept up by placing the dish upon a tin box containing hot water, and kept warm by a spirit lamp placed beneath it.

The paper is floated for about three minutes, and hung up by two corners to dry in a room which is non-actinically lighted, and is perfectly free from dust. When dry, the paper must be floated again as before. The sheets should be hung from the opposite corners to those by which they were hung after the first flotation. Should it be considered desirable to coat the paper with gelatine first, and then sensitize, the dichromate may be omitted from the foregoing formulæ. The sensitizing is then effected by floating the prepared paper for one minute on a cold solution of—

Potassium dichromate	...	...	...	1 ounce
Water	...	...	...	15 ounces

In both cases it is well to pass the sensitized paper through a copper-plate or lithographic press, as a fine smooth surface is thus given it.

The sensitized paper will keep from about a week in cold to one day in hot weather.

The negative should preferably be perfectly opaque in the whites, and no clogging or deposit must mar the transparency of the lines. It will be found that great pressure is required in the printing-frame to bring the paper and the negative in close contact throughout. The difficulty is increased considerably if the plates are not perfectly flat; hence, for these negatives, patent plate is recommended.

The amount of exposure to be given requires great judgment. With paper of a most sensitive character, and with a negative in which the whites are extremely dense, and the lines perfectly transparent, from half a minute to two minutes' exposure in bright light will suffice, whilst an hour may not be too long in dull

* The gelatine should soak in water just sufficient to cover it, and then the remainder of the water should be added in a boiling state.

weather. The surest indication of proper exposure is that the lines should appear of a dark reddish-brown on a yellow ground. Should a negative be weaker in some parts than in others, the weak parts may be shaded by tissue paper, or paint applied on its film side.

The prints have now to be coated with greasy ink. At Southampton the following formula for the ink is used :—

Lithographic printing ink	...	...	8 ounces
Middle varnish...	...	...	4 „
Burgundy pitch	...	...	3 „
Palm oil	...	...	$\frac{1}{2}$ ounce
Wax	...	...	$\frac{1}{2}$ „
Bitumen	...	...	1 „

The ink and varnish are first ground well together with a muller on a stone slab. The Burgundy pitch is next melted over a clear fire till the water is driven off. The wax is next added to it in small pieces, and finally the palm oil. These are well stirred together. When properly heated, the vapour from the mixture should catch fire if a light be applied, and then the bitumen is added, and the contents of pot ignited again. The ink and varnish are now added little by little, the stirring continuing the whole time. The pot is now taken off the fire, and when the contents are cooled they are poured into tins for storage. The condition of the ink is of the greatest importance. It must not be too soft, otherwise the sponge used in development will become clogged. If the ink be too hard, it will be difficult to develop at all; in this case more palm oil should be added.

To commence inking-in the print, a small quantity of the ink should be taken, and laid upon a flat stone slab, and melted with turpentine sufficient to give it the consistency of honey. This is well worked with a lithographic roller on a smooth stone, or its equivalent, to a fine even surface. A print is now taken and laid face downwards upon this inked stone, and is passed once or twice through the lithographic press. On carefully raising the paper, it will be found to have taken a fine layer of ink, through which the detail will be faintly visible by transmitted light. The coating of ink may also be given by a sponge or hand-roller, the paper being pinned firmly on to an even board, face uppermost. The finer the layer of ink, the better will be the developed print. These operations should, of course, be carried on in non-actinic light.

The print is now *flooded*, *face uppermost*, on water of about 90° Fah. It is allowed to remain on this till the lines are seen in bas-relief on a swollen-up ground. It is next transferred to a sloping zinc or glass plate, and warm water of about 150° is poured gently over it. The soluble gelatine is removed by *gentle* rubbing with a very soft sponge, but should the inked soluble gelatine not leave the paper entirely at this stage, the prints should be *soaked* in warmer water for about an hour, when the sponging should be repeated. When the sensitized gelatine is moistened it becomes almost insensitive, consequently these operations may be performed in ordinary weak daylight. A constant flow of water from the sponge must be kept up to remove the inky gelatine after it is loosened, otherwise stains may result. It should be borne in mind that the utmost care is required in the sponging: if the sponge be roughly handled the fine lines will be removed, and spoil the print for transfer.

The prints, when freed from the soluble gelatine and ink, should be well washed in dishes of cold water, and hung up to dry. They are then ready to transfer to stone or zinc, but it is better to leave them a day, before the transfer is made.

TO MAKE A TRANSFER BY PAPHYROTYPE.

Any tough paper is coated with a fine layer of gelatine, and subsequently treated with chrome alum or alum. It then receives another coating of gelatine of the same formula given for the Southampton method, substituting flake gelatine (for cheapness' sake) for the fine cut. The printing is not carried on to such an extent as in that method, but the lines must appear of a delicate fawn colour on the yellow background. After withdrawal from the frame the print is drawn through *cold water*, and is then squeezed down on to a smooth zinc or pewter plate. If found necessary, the edges may be secured by strips of paper and india-rubber solution, as for the heliotype process. The superfluous water is then blotted off, and a gelatine roller (of not too adhesive a character) is charged with ink. The ink is made as follows:—

Best lithographic chalk ink	...	...	4 parts
Palm oil	...	...	1 part

A small portion of the ink is spread upon a stone slab as in ordinary lithography, and after the roller has taken an even

coating, it is applied to the paper. The gelatine has only absorbed water where it has been unacted upon by light; consequently, the lines alone will take the ink, the "whites" remaining free. After the paper has been well charged with ink, it may be necessary to pass the roller smartly over the surface to remove any scum that may be adherent. The finished transfer will be found of the most delicate character, and possessing great sharpness.

It is essential that but very little of the bichromate of potash should leave the paper, as the success in transferring mainly depends upon its presence. The transfer print is hung up to dry, and is then again exposed to light. The whole surface now becomes insoluble, and on re-damping, previous to placing on the stone, it has no tendency to stick, nor will the gelatine be squeezed away by the pressure of the scraper in the press. There will still, however, be sufficient adhesiveness left to retain the paper in position. It will be noticed that this process has the following advantages:—

1st. The ink which forms the lines is not left on ridges of gelatine, as in the Southampton method.

2nd. There is no danger of removing the ink from the fine lines.

3rd. The ink may be applied till a satisfactory result is obtained.

4th. Two inks may be used of different consistencies; the thick ink will give solidity to the thick lines, whilst the fine lines will take a thinner.

5th. The surface of the transfer will have no tendency to slip, as the whole is partially adhesive.

CAPTAIN WATERHOUSE'S PROCESS.

In the Surveyor-General's Office in India, Capt. Waterhouse found that papyrotype did not come up to his expectations, probably owing to the heat of the climate, and he introduced a modification of the Southampton method, a description of which is taken from a communication to the Asiatic Society.

Paper is coated with two coats of gelatine and potassium dichromate as in the Southampton method, and is put away to harden and to become insoluble. When required for use, it is coated with a mixture of gelatine and potassium dichromate of about

one-third the usual strength, and is then exposed to light, and inked in the usual way.

Instead of allowing the gelatine to harden by keeping, the hardening action may be hastened by allowing the light to act on the back surface for a minute or two. This may be done either after the print has been obtained, or after the preliminary coating has been given to the paper. It has been found that this method has the advantage that a base of insoluble gelatine remains on the paper and retains the finest lines, whilst the fresh coating preserves the clearness of the ground. If the underneath gelatine be not well hardened, the gelatine tends to stick to the stone or zinc, and the soft gelatine is liable to spread over the lines and to prevent their transfer. The ink is removed by cold water and a sponge, leaving the lines crisp, and the spaces between them free from scum.

PREPARATION OF THE STONE AND ZINC PLATE, AND MODE OF TRANSPARENCY.

It is not proposed to give a detailed description of the apparatus for lithography, or zincography, as a respectable manufacturer will supply them of a proper character. A list of the articles necessary to procure is, however, given at the end of the book.

Both lithography and zincography depend on the property that a calcareous stone or mulled zinc plate possesses for absorbing or holding water, and on the fact that the grease is repelled by water; thus, where there is grease on a stone or zinc plate (present through accident or design) the water is repelled. If a roller now be charged with greasy ink, and passed over the surface while still damp, the greasy ink will "take" in those portions where grease was originally on the surface, whilst the other portions remained unaffected. (The slightest trace of grease on the plate is sufficient to attract the ink from the roller.)

Preparation of a Stone.—To prepare a lithographic stone for taking the transfer from a drawing, if the surface be uneven, or if a drawing has previously remained on for a considerable time, it may be necessary to grind it down, either by a stone, or by an iron levigator. In both cases fine silver sand is sprinkled between the two surfaces, moistened with water. When the old work is removed, and the surface level, it is thoroughly washed with clean water, and polished with soft pumice stone. The pumice

stone is moved backwards and forwards till all grain is removed, when it is again washed with a sponge and water, and finally brightened up with snake stone. After another washing it is allowed to dry, when it is ready to receive the transfer. The polishing with pumice and snake stone will take about a quarter of an hour.

Preparation of Zinc Plates.—The zinc plates are supplied by manufacturers, of proper weight, and ready planished. They should be about 10 B W guage. To be prepared for receiving a transfer, they must be grained. Brass founders' moulding sand is the best form of sand to use, as others, particularly silver sand, is apt to scratch the plate, and, prior to use, the sand is sifted through a fine sieve of about 150 holes to the linear inch. A zinc muller is used to grind the surface after the sifted sand (moistened to the consistency of a cream with water) has been sprinkled on the surface. It is worked slowly round and round with a spiral motion, till the surface after washing appears of a uniform dull grey tint. Any traces of previous work must be obliterated, and all scratches must be ground out. The mullers should be kept free from all accidental grit, and be carefully cleaned before use. The zinc plate whilst mulling may be laid on any flat surface. A plate should be mulled immediately before use.

Transferring to Stone or Zinc.—The stone is slightly warmed either before a fire, or, what is more expeditious, by pouring over the surface a kettleful of boiling water. The heat in this latter case dries the stone, and leaves it sufficiently warm, though there is a danger of the heat being too evanescent. The transfer is *slightly* damped, either by a moist sponge* or by damping a sheet of blotting-paper which is placed at the back.

Whilst this is taking place the stone is placed on the bed of the press, and the first operation is to ascertain that the scraper is perfectly true. Should it not be so, it may be adjusted by placing a piece of sand-paper on a perfectly flat surface, and rubbing it down till it is perfectly level. The stone should now be "pinched" by the lever between the bed and the scraper, a piece of clean paper protecting its surface from the leather tympan. If the same amount of pinch be apparent at all parts of the stone, it is ready for use. If one end have less pinch than the other, the former must be raised by laying under it

* The top surface of the transfer should never be sponged.



Papvrotpe. S. M. E.

A DERVISH. From a design by Venetichagin.

*Reproduced from J. A. Mac-Gahan's Campaigning
on the Oxus &c., by permission of Messrs Low & Co.*

a few folds of paper, taking care that the folds gradually taper off as they approach the centre of the stone. The stone must next be passed two or three times through the press, in order that it may take its final bearings, after which the transfer is laid on the stone by two corners, and a couple of sheets of paper* are laid over it. After the tympan has been brought gently down, the stone is passed through the press two or three times. The amount of pinch given should be light for the first pull, it being increased for each subsequent one. The tympan is now raised, and if the transfer adhere tightly to the stone the scraper may be reversed, and the stone is passed through the press a couple of times more. In order to remove the transfer paper it may be necessary to soak it with water. This done, the surface of the stone is moistened with gum water, and allowed to dry and cool. This is most important, as if it be used too fresh or whilst warm, the lines may spread, and give coarse and broken work.

The stone is fixed on the press, and the gum is washed off with a soft sponge, and the moisture distributed with a damping or cheese cloth. Ordinary lithographic ink having been worked to the consistency of honey, a little is laid on the roller and worked about on the ink slab till a fine even layer is spread over its surface. *Whilst the stone is moist* the roller is passed over it from time to time, fresh surface being brought to bear on the work. By this procedure it will be found that the lines take the ink. If a slight scum appears whilst rolling, it is probable that the stone is not sufficiently damp. A fresh application of the sponge and damping cloth, and a smart roll, will lift it, leaving the surface clean. The stone is next slightly etched, to prevent spreading of the lines. A very dilute solution of nitric acid in water effects this. A sponge moistened with this should be passed over the surface, and, after leaving it for two or three seconds, fresh water should be applied with the damping cloth. A little gum-water is then applied, wiped off, and the inking proceeded with again. It may happen that all portions will not take the ink alike—that portions are weaker than others; in this case, over those parts should be spread thick gum, and *through* it should be rubbed a little palm oil, spread on a small square of cloth. This *generally* gives the required intensity. Impressions are now pulled, inking-in between each.

For zincography the process is very similar; the transfer is

* Preferably a piece of transfer paper.

damped and passed through the press as above, the zinc plate being screwed on to a flat block of hard wood, so as to lie evenly and to be of sufficient height on the bed. When the transfer is removed the plate is well washed, and fanned dry. An etching solution is made thus :—

Decoction of galls	...	...	...	1 quart
Gum-water	....	...	...	3 quarts
Phosphoric acid	...	...	...	3 ounces

The decoction of galls is prepared by soaking four ounces of bruised Aleppo galls in three quarts of cold water for twenty-four hours; the water and galls are then boiled together and strained. The phosphoric acid is made by placing sticks of phosphorus in a bottle of water, so that the ends of the sticks are exposed to the air. The etching solution is brushed on the plate with a broad brush, and allowed to remain a few seconds; the excess is then wiped off with a cloth, and the zinc plate is fanned dry. It is then washed and rolled up as before. The first few impressions, either from stone or zinc, are generally feeble, and may have to be rejected.

A GUM PROCESS.

Take Rive paper, and brush over it a solution of—

Picked gum-arabic	...	...	...	25 grains
Potassium dichromate	...	...	...	85 „
Water...	...	...	...	1 ounce

Hang it up to dry. This will be accomplished in about half-an-hour in warm weather.

The sheet of paper must be placed under the negative as usual, and exposed to the light. When every detail is clearly seen, the paper should be withdrawn.

Take ordinary printing-paper, and soak alternate sheets in water, blotting the excess of moisture off in blotting-paper. Make these in a pile (about six sheets of moist and dry will be sufficient). Place the printed paper on the lithographic stone or sheet of mulled zinc, place a dry sheet of paper on its back, and then on it place the pile of damped paper. Finally, place a sheet of zinc or other flat surface on the top. The stone or zinc plate and its load should next be pressed under an ordinary book-binding press, and a considerable

pressure brought on to it. It should be left under this for half-an-hour.

The paper is then removed from the stone. Those parts of the gum which were rendered insoluble will leave the stone with the paper, the remaining portions adhering to it. After thorough drying away from light, a little oil is poured or brushed over the surface. The gum protects the white portions of the print from its action. The stone may be cleaned from the gum with a sponge and tepid water, and the ordinary lithographic process may then be proceeded with.

The process is simple, the drawback being that the gum penetrates to a considerable depth through the surface of the stone, rendering the preparation for fresh work tedious.

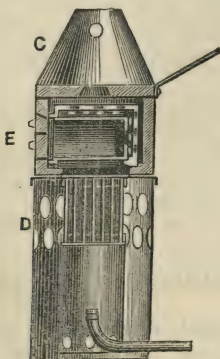
PHOTOGRAPHIC ENAMELS.

There are two methods of producing photographic enamels which have been practised in this country; the one by what is called the dusting process (similar, in fact, to the powder process, described at page 157), metallic powder being employed instead of the plumbago; whilst the other is dependent on the production of a transparency in collodion, the image being toned by various metallic compounds. The first process will not be described, as it is believed that the second is capable of giving better results.

A muffle for this process is absolutely essential. A form for placing in an ordinary fire is supplied by many dealers; but, when feasible, it is advisable to have one which is heated by gas, as there is no danger of discolouration from smoke, sulphur, &c., which is sometimes the case when coal or coke is the source of heat. Fletcher, of Warrington, supplies a most excellent gas furnace for the purpose (see page 180). It can be fitted on to any ordinary gas supply, and attains sufficient heat in a quarter of an hour to fuze any enamel placed within the muffle.

The first step in the production of an enamel is to produce a fully developed transparency of the subject to be copied. This is secured in the camera in the usual way, or by contact printing, and when fixed should appear very vigorous, though with half-tones of a most delicate character. The next operation is to

detach the film from the glass plate. This is effected by placing it in distilled water (to which, if the film be refractory, a little dilute sulphuric acid has been added), and after a thorough soaking it can be removed by a camel's-hair brush, deftly applied at one edge. The sulphuric acid is sometimes an advantage if the collodion be tender, as it toughens it; but



E is the muffle door closed with fire-brick (shown in section); D shows the draught-holes opposite the burners, which are a series of pipes; C is a movable piece to which is attached a chimney. The muffle part can be removed, and an alternative portion is supplied for heating crucibles, &c.

great care is requisite to ensure that all traces of it are eliminated before proceeding further. The writer has in many cases toned the transparency before detaching the film from the glass, but the action is slower, owing to the fact that only one surface is open to the deposit of the metal.

There are several toning solutions which are all effective, though the colour of the finished enamel varies according to the metal employed. It may here be remarked that there are two methods of burning a picture on an enamel—one in which the image is absolutely burnt into the plaque; the other in which a soft flux is melted over the metallic image, giving it merely a glaze. The first plan is real enamelling, the metal forming a compound with the composition employed; while with the latter the image is merely superficially protected, and is not, therefore, so likely to resist injury. For absolute success with the first method it is merely essential that all silver should be entirely

eliminated from the image; for if a true silver compound be formed, the image on burning will have a dirty canary colour, which no subsequent treatment can efface, though by regulating the temperature some operators can burn-in just sufficient to cause the image to sink into the enamel. The composition of the plaques materially affects the tone, hence there is often a discordance in the results obtained by different operators, unless the same materials be used. With plaques supplied by some manufacturers the platinum toning bath gives a rich velvety black colour. The toning bath employed is—

Platinum tetra-chloride*	...	...	1 grain
Water	...	...	20 ounces

to each pint of which 4 drops of concentrated nitric acid are added. This gradually converts the film of the image into silver chloride, and causes a consequent deposition of platinum. As one equivalent of platinum displaces four of silver, the reason why a rather dense transparency is required is apparent. The toning operation can scarcely be continued too long when the transparency is of proper intensity.

Another toning bath, suggested by Herr Grune, is to tone first with platinum, and then to remove the film to a solution of uranium ferri cyanide. Half a grain of uranium nitrate and half a grain of potassium ferri cyanide are dissolved in a pint of water, and this solution is employed. When a slight browning action is observed, the fused image will have a sepia brown tint. Iridium chloride of a strength about the same as the platinum chloride is also employed by some enamellers with very good effect, the tint of the picture produced being a delicate grey.

After well washing,† the film should be treated with ammonia solution, half ammonia and half water. This dissolves out the silver chloride, and leaves an image formed of metallic platinum and silver. To eliminate the latter, after thorough washing in distilled water, it is treated with nitric acid and water (half acid and half water). This finally frees the image of all traces of silver if it again be thoroughly washed.

The picture, thus finished, is allowed to remain floating in a

* Previously neutralized with sodium carbonate.

† The film must be thoroughly well washed, in order to free it of any trace of the platinum solution; otherwise, by the subsequent treatment, a deposit of the metal may take place on the whites, and spoil the picture.

dish of distilled water, and when the plaque is brought beneath it they are both brought out of the water together, the film clinging to the surface of the plaque.

The film is trimmed by a penknife so as just to cover the edge of the latter, and after a few strokes of a fine camel's-hair brush, collodion and enamelled surface will be found to adhere together without crease or wrinkle. After drying thoroughly, the plaque is placed on a small sheet of cast iron or a small brick, and placed in the muffle, and the heat applied. The process of burning-in can be readily watched, and the instant that it is complete may be judged by the appearance of the surface of the enamel. First, the collodion film* disappears, next the whole plaque becomes red hot, and the image seems to disappear; a few seconds after this effect is observed, it should be withdrawn, and it will be found that the burning-in is finished.

The enamel appears dull and devoid of gloss, and it is consequently necessary to apply a glaze to it. The glaze employed is that known as *soft glaze*, as supplied by various china manufactories. This can be shaken up with plain collodion, and so emulsified that on coating the plaque the image is completely hidden by the white surface due to the fine powder. When dry, another burning is given, but only to such an extent that the soft glaze becomes liquid, after which it is withdrawn. It frequently happens that two or more glazings are required before the right lustre is obtained.

The art of enamelling is practised by very few photographers; those whose productions are worthy of notice could be named on the fingers of one hand. The method given above is founded on that of Herr Grune, and it is believed that most enamels are produced in a somewhat similar manner.

PHOTO-RELIEFS.

THE production of satisfactory photo-reliefs of etchings, &c., has long been a desideratum in the printing trade, and many attempts have been made to secure such. The following process answers well for their production in zinc.

* If the sulphuric acid used in the first soaking to detach the film have been too strong, it often explodes, and carries away the image with it.

A transfer in hard transfer ink from a negative is made as if for lithography and zincography. A one-eighth of an inch zinc plate is then thoroughly mullied as described at page 176, after which it is rubbed down to a smooth surface with pumice, and then with stick charcoal. The appearance of the plate should be such as to be almost polished, and all visible grain should be absent, particularly if the work to be reproduced be fine. The transfer is then placed on it, and passed through the lithographic press in the ordinary manner, and a good firm impression left on the prepared surface. The plate is now dusted with fine resin or colophony (the dust being passed through a muslin bag to prevent any lumps adhering to the plate), all that does not adhere to the greasy ink being blown off. A solution of—

Hydrochloric acid	...	...	...	1 part
Water	...	...	...	500 to 750 parts

is next prepared, and placed in a flat dish which is sufficiently large to hold the plate, and which can be rocked mechanically. The solution should be of such a depth that when the dish is fully tilted in one direction the surface of the plate should be a little more than half bare. The surface of the zinc bearing the picture is next flooded with a dilute solution of copper sulphate (10 grains to the ounce), and a fine black deposit of precipitated copper is left.

In this stage we have a zinc-copper couple, the contact between the two metals being so complete that the voltaic action is able to decompose a variety of liquids hitherto not easily acted upon. The coppered plate is immersed in the acid solution, and an immediate evolution of hydrogen shows that an action is taking place, the zinc gradually being attacked where the copper is opposed to it. It should be remarked that the acid solution is so dilute that it has no susceptible effect on uncoated zinc, hence those portions covered by this greasy, resinous transfer ink are not acted upon. The dish containing the acid should be constantly rocked to cause the bubbles of gas to disappear, and on this rocking depends the success of the process. After twenty minutes in this solution, the slow evolution of hydrogen will show that the acid is nearly exhausted. The plate should then be withdrawn and washed under the tap. It should next be warmed to soften the ink and the resin, and more ink should be rubbed into the lines, as is done in rubbing up a

lithographic impression. The dusting process is again resorted to as before. The copper solution is applied, and after washing, the zinc is again immersed in an acid solution (this time of double the strength of the foregoing), and the same motion given to the dish. These operations are again and again repeated, the warmed ink and resin gradually running down the raised lines and filling in the close spaces. When a sufficient depth is given to the close lines, the large portions of the block which should print white may be sawn out with a fine saw. The zinc relief is then mounted on a wooden block for printing purposes. When printing off large numbers, zinc is liable to damage, and printers seem to object to this metal. Electrotypes may be taken from the zinc reliefs, and, when faced with steel, leave nothing to be desired.

It should be remarked that the employment of copper prevents local electrical action in the zinc when iron or other impurities are present, hence the metal may be that ordinarily to be obtained in commerce. The most successful worker in zinc, as far as the writer knows, is Gillot, of Paris, many of whose productions are undistinguishable from the best woodcuts. The economy of this method of producing relief blocks is the fact that two or three square feet of them may be executed at the same time, very little additional labour being required.

A very short way of obtaining blocks for relief printing is by treating a lithographic stone in a similar manner (omitting the copper solution), and using a hot iron for melting the ink and the resin. A mould is obtained from this in wax, paraffine, or gutta-percha, and an electrotype taken. Great depth is more easily obtained on a lithographic stone than on zinc if the manipulations are carefully attended to. Constant practice is required in these processes to ensure success.

PHOTO-ENGRAVING.

THERE are various methods of producing photo-engravings which are employed by different firms; but, so far, the best seems to be that based on the original process of photography, viz., on the action of light on asphaltum or bitumen of Judea. This substance is dissolved in benzole or chloroform, and a thin coating given to the copper plate by flowing it over as collodion would be. When

dry, the colour of the copper should be visible through the coating. The plate is then exposed behind a film, and after half-an-hour's positive sunlight, or its equivalent in diffused light, it is developed. The developing consists first in softening the soluble portion of asphaltum with olive oil, to which subsequently a little turpentine is added. This gradually dissolves away the asphaltum, and leaves the lines bare and ready for the action of the etching fluid.

The development must be very gradual, and the turpentine and oil washed away with water directly the lines are bare, otherwise the action of the solvents will continue on the parts which have been acted upon by light, and the image will gradually disappear.

The etching solution will be as follows:—

Potassium chlorate	...	...	...	1 part
Hydrochloric acid	...	...	...	10 parts
Water	...	...	...	48 „

After the developed plate has been immersed in this solution a short time, the weakest lines will appear to be etched, the stronger lines taking the "bite" quickest. When the former are judged to be of sufficient depth, the asphaltum is removed by benzole, and the plate is ready for the copper-plate press.

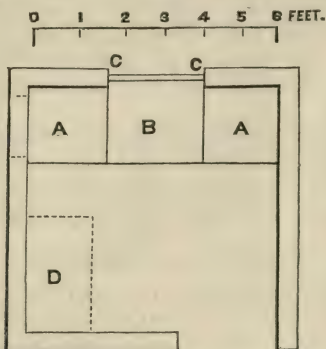
HINTS ON APPARATUS, ETC.

THE DARK ROOM AND ITS FITTINGS.

THE generality of dark rooms are too small for health, and certainly for comfort, a mere cupboard often being substituted for a well-ventilated room of moderate dimensions. A certain amount of cubic space will be doubly necessary if many hours are to be passed in preparing plates and developing.

The following figure shows a plan which will be found convenient. It is a room only six feet square, which, we think, is the minimum that should be allowed, if it is the only photographic den available for all purposes. A is a working table from 2 feet 9 inches to 3 feet high, and B a small lead sink 2 feet by 1 foot 6 inches in dimension, and 6 inches deep. The sides of the table should have a small inclination of (say) half-an-inch towards the sink, in order that all water may drain into it. The table may also be grooved with the same

object, except a small portion on which the developing cups may be allowed to stand temporarily. The water is conveniently



admitted by a stand-pipe, from the top of which springs a moveable arm with a tap; at the extremity of the arm is suspended an india-rubber tube with a fine rose attached.

This plan enables a plate to be flooded with water without endangering the film, and the arm may be swung back when water is not required. A lid to cover B will give a table on which dishes during sensitizing paper and other necessary operations may be placed.

It is often supposed that it is necessary to work in an almost dark room. This is quite contrary to reason, so long as the light admitted is of the proper quality. In the sketch, the window, *cc*, has been shown 2 feet wide; it may be 2 feet high, and glazed with what is known as stained red glass, all light transmitted by it being of an orange colour (see page 200), and perfectly without effect on bromo-iodide of silver. If the sun shine on the window, it may be convenient to shade the window by a yellow tammy curtain running on rings on a rod fixed to the top of the window-frame.

In developing silver bromide films as prepared by the emulsion process it will be advisable to have a loose frame made, fitting into the windows, on which is stretched varnished silk, or gelatine impregnated with magenta dye (see page 200). D is a drying cupboard, which may be used for drying either plates or sensitized paper. For convenience the bottom should be at least two feet from the floor.

For warming the room in winter, after a fair trial we are convinced that there is nothing better than one of the well-known calorogens, and it can be utilized for heating the drying cupboard.

We have omitted saying anything about shelves in the dark room, as the operator must suit his own convenience about them. It will be found desirable, however, in every case to have a couple of narrow shelves over the right hand side of the working table, on which the developing cups and bottles and plate-holders can be placed. A distinct shelf should be allotted to the plate-dusting brush, and for the collodionizing plate-holder. The bath-holder should stand on the left-hand side of the sink, and be fitted with a loose cover of wood or brown paper to protect the plate during sensitizing when the door is opened.

THE DARK TENT.

For operating with the wet process in the field it cannot be expected that there should be the same conveniences as are to be found in the dark room. The wants of the operator must be curtailed to some small extent, and this curtailment will be found of no detriment when his chemicals are in good working order, and when he has had sufficient experience at home to keep them so.

There are a considerable number of dark tents which are capital for field work. A box tent is handy, as it will carry all the chemicals necessary for a day's photography. Rouch's pattern is excellent; that as modified by the writer has a few improvements which add much to the comfort of manipulation. For hand carriage a tent should not weigh more than 25 lbs., including chemicals. Stillman's manipulating box is handy, and also the knapsack tent, for small pictures. When a tent is erected it should, if possible, be placed in the shade, and the window must in any case be turned away from direct sunlight. Before trusting to a tent, it should be tested by placing in it a sensitized plate for a couple of minutes, whilst the window is closed. Should the plate remain unaltered by development it may be taken for granted that the tent is fit for use.

The lightest form of tent with which the writer is acquainted is that by Howard, and in a recent tour abroad he has found it so convenient for working in with plates up to $8\frac{1}{2}$ by $6\frac{1}{2}$ that he is induced to give a detailed description* of it, since it can be

* Taken from an article by the writer in the PHOTOGRAPHIC NEWS, 1878.

made by anyone. The essential principle of this tent is that it can be fixed on to the camera legs, and moved from place to place without the necessity of taking it down. It weighs only three pounds, and another seven pounds may be added for the weight of the box containing the chemicals. This additional weight of ten pounds to that of the camera is so little that it enables the photographer to work the wet process in the field without the necessity of employing a porter to aid him in carrying his traps.

A general idea of the tent when finished will be seen in the figure (fig. 1). The tent itself is hung from under the camera



Fig. 1.

legs, and is in reality a bag. In the earliest form it was a triangular pyramid; but Mr. Howard (and we quite agree with him) considers that this shape is not so convenient as a square one.

We will suppose we are to make one of stuff. In all cases half an inch more than the dimensions figured in the drawings is to be left for turning in and binding, and also, except for the bottom, three thicknesses of material* must be used. First of all, cut out

* The article may be of drab twilled calico, the centre of black twill, and the inside of Turkey red or yellow tammy.

in brown paper the shapes given in figs. 3 and 4, and two of the shape of fig. 2 (figs. 3 and 4 are the back and front respectively, fig. 2 is a side piece), and then cut out in the material to be used from these patterns. Tack FH and BD together, and BAC to

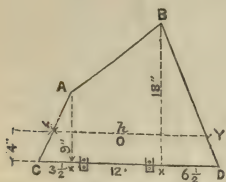


Fig. 2.

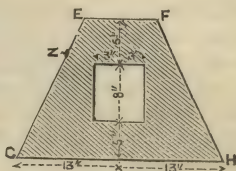


Fig. 3.

NOP, and BAC of the second piece cut out to fig. 2 with KLM; the points O and L should coincide with the point A, but leave the side EG detached from BD from below Z.

Cut out a piece XYDC (fig. 2), and tack the edge XC to ML, and YD to GZ, and also YD on to GE, so as partially to close the

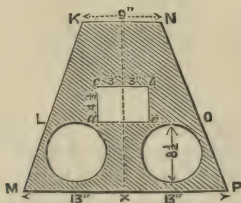


Fig. 4.

side, which is otherwise covered only by a loose flap. Next cut out the bottom (in this case one thickness of drab cloth and one of waterproof sheeting is recommended), which must be twenty-six inches by twenty-two inches, and sew it to GHMP. The main form of the tent is now complete. The left side being open allows access into the interior. It is manifest, however, that the left side can never be light-tight left as it is. A band, therefore, four inches wide is sewn along EG, the end near E being cut away to fit the shape of the front, whilst the other end is sewn to the XYDC piece. Another flap four inches wide is sewn on to the back, one and a-half inches from

EG, and parallel to it. When the loose side is now hooked on to the first band, and the last flap is hooked over it again, it is manifest that, as far as the edge of EG of the tent is concerned, no light can enter, since the edge of the loose side is fitted, as it were, into a groove. The same method is adopted for the bottom of the loose side. The interior piece is already present in the XYDC piece, and it only remains to fix a broad flap some four inches wide from the edge of the bottom piece, in order to make the whole tent light-tight. It will be found that four hooks on each edge—that is, sixteen in all—will be sufficient to close the side. In fig. 3 the rectangular opening in the centre is the window, and should be filled up with adiactinic cloth, or else two thicknesses of red or yellow calico. The two circular openings in fig. 4 are holes in which to place the sleeves. These should be of india-rubber sheeting of about the thickness sponge-bags usually are made. They should be about twelve inches in length, and taper to about four and a-half inches in diameter; the ends of these should be turned over, and a piece of elastic run in and joined, so as to cause the sheeting to fit closely over the wrists. The other rectangular hole is for the mask. The mask

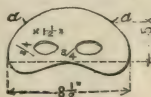


Fig. 5.

is of the shape shown in fig. 5, and it should be made of stout india-rubber sheeting, and faced with black velveteen. A little cotton-wool padding introduced between the two to fill up the gap which occurs between the forehead and the bridge of the nose is often useful, as is also a slight pleat made at *a*, in order to cause the top to curve over and fit the forehead. To fit the mask on to the tent a bag is made to fit into *b c d e*, the outside dimensions of which are on the top three inches, and at the bottom half-an-inch. Fig. 6 shows a section of the mask and the front of the tent; this may be made of the thicker india-rubber sheeting. An elastic band secures the mask round the head.

At about four and-a-half inches from the left side of the tent, and with the longest side parallel to the side of it, a hole is cut in the bottom to carry a bag, in which the bath is placed. The dimensions must, of course, vary with the size of the bath; but it is convenient to have the top of the bath one inch above the

bottom of the tent. In the centre of the bottom a small circular hole is cut, into which is fastened a small brass tube, from which an india-rubber pipe can be fixed to carry off the waste water if necessary. On the right side of the tent is shown another hole (h, fig. 2), to allow the entry of the pipe from the water-bag. To close this hole round the pipe, the writer has found that if two patches of india-rubber sheeting be bored to a diameter a little less than the piping, and one be fastened inside and the other outside of the cloth, all light is excluded. In practice, the writer has fixed a length of tubing into the hole,

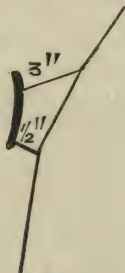


Fig. 6.

of sufficient length inside to carry the water to the plate, and closed by a clip, whilst in the other end is inserted a piece of glass tubing, by which a junction is made with the india-rubber pipe fastened on to the water-bag. A few pockets inside complete the internal fitments. On each side, two sets of tabs are sewn, having two or three eyelet holes in them. The use of these will be shown presently. When all the pieces are tacked together they should be bound with braid, and at every corner strong hooks should be fixed as suspensors for the tent from the camera legs. Thus hooks at C, A, and B will be necessary to fasten A and C to the *front* camera legs, and to secure B to a cross-piece attached to the hind camera leg.

The top cross-piece (the distance at which it is fixed from the top of the stand must vary with different stands) must be about ten inches long by about three-quarters deep and a quarter wide, and be made of ash or other strong wood; it should be pivotted on to one branch of the leg, and kept in position, when the tent is erected, by a small block screwed on to the other branch. The bottom cross-piece of wood should be about twenty-eight inches long, and, as it is heavier than the

top bar, it is convenient to carry it loose, and screw it on by a thumb-screw when the tent is to be erected. It should be rather thicker than the top cross-piece, as it has to bear more strain. Rings such as used for picture frames should be inserted at the ends of these pieces in positions which are self-evident.

The same kind of rings should also be screwed into the camera legs to support the other points to which hooks are to be attached.

When the camera legs are stretched out the tent will now be complete; but to give stiffness, two iron rods of the thickness of thick iron wire of the length of the bottom of the tent are made with eyes at their ends, and tied to the tabs shown in fig. 2. These help to support the bath, and form a support on which the developing tray can rest.

The box containing chemicals may be made of light pine, with a carrying strap strongly screwed into the ends of the box. This should contain the bath in its holder, a box of plates, a bottle of concentrated developer, and a small water bag, a gutta-percha developing tray (across which are stretched two light wood rods to support the plate), a developing cup, and plate-holder. The height of the box should be such as to allow the operator to be seated comfortably when his face is inserted in the mask. When developing the dish is inserted in the tent, and the developing solution and cups stand in it. The water-bag is slung from the legs, and the clip attached to the tube. The slide containing the plate is placed in the tent, the side closed. The hands and face are inserted in the sleeves and mask respectively, and the development carried out as usual. The plate is washed and floated once with a dilute solution of potassium iodide, and again rinsed. The hands and face are liberated, and the plate put away for intensification and fixing at home. The developing dish is taken out and emptied, and the operations are ready to be repeated. We have given no directions for sensitizing, as the method is self-evident, though we may remark that the plate may be coated outside the tent, and be inserted in the bath through the opening in the side.

THE CAMERA.

For out-door and landscape photography the camera should be of the lightest possible make, as far as is compatible with rigidity. That form which is known as "the bellows," with parallel sides,

when properly made, fulfils these requirements better than any other. In it the lens remains fixed, whilst the ground-glass is made to move to attain proper focus. This will be found of great convenience. *Every camera* should have a "swing-back;" that is, the ground-glass should be made to hang plumb when required, supposing the camera to be tilted. For portraiture the same class of camera may be used, though a heavier kind for this purpose is not objectionable; the body may be rigid, in which case focus would generally be obtained by movement of the lens. For hot climates and rough usage brass binding to the woodwork is recommended, and Russia leather for the bellows; cockroaches and white ants will not attack the latter.

For an amateur photographer, $8\frac{1}{2}$ by $6\frac{1}{2}$ is recommended as the maximum suitable size. Figure 1 shows a very good form in-

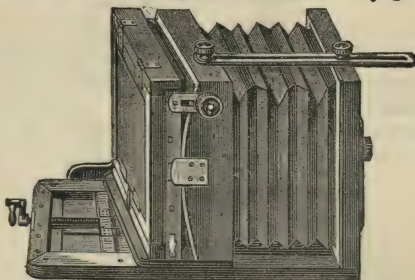


Fig. 1.

roduced by Meagher, which the writer has worked with for many years.

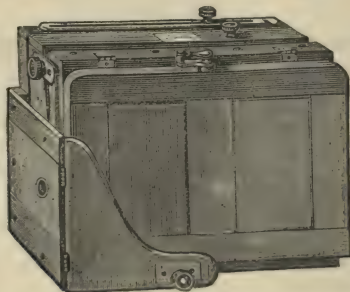


Fig. 2.

Fig. 2 shows the camera when folded up. Three double backs

for dry plates, with the camera, can be well placed in a leather case, and will be quite within the weight for carrying.

Another form of camera (shown in fig. 3) is one patented by

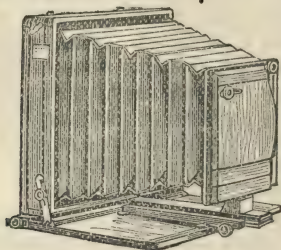


Fig. 3.

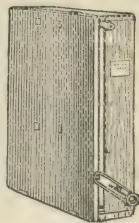


Fig. 4.

Messrs. Rouch and Co. Fig. 4 shows its shape when shut up. It is very light, and has a double swing-back. The focussing takes place from the front.

Fig. 5 shows a camera by Meagher which is adapted for

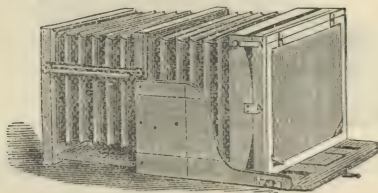


Fig. 5.

copying purposes, occupying the same space, when closed, as fig. 2, but having an extra length, which is pushed forward beyond the ordinary camera front.

The cut is taken from an $8\frac{1}{2}$ by $6\frac{1}{2}$ camera, and the length of focus obtainable is 24 inches, whereas in the ordinary form, without the extra length, it gives about 12 inches focus.

The Scenograph is a pocket camera adapted for taking $6\frac{1}{2}$ by $4\frac{3}{4}$ pictures. It is very light, and is very rigid, considering its small height. The legs form a walking stick by a neat arrangement. To a careful (*not a rough*) photographer the scenograph is worthy of attention.

Before taking a camera into use, care should be taken that the inside of body is made *dead black*, otherwise reflections

on to the plate may occur, giving a foggy appearance to portions of the negative. The mode of testing this instrument will be patent to all; the chief defect to be looked for being a want of coincidence of the rough surface of the ground-glass with the plane of the silver wires, &c., which support the sensitized plate in the dark slide. Perhaps as simple a method as any of testing this coincidence is to place a dry plate in the dark slide, open it back and front, and focus on the film. The slide is then withdrawn and the focussing screen replaced; if the focus on the latter is correct, the adjustment is complete. Well seasoned mahogany is the wood most suitable for a camera, and it should be borne in mind that polish gives greater durability to it.

CAMERA LEGS.

The camera legs should be of such a length as will allow the lens to be raised some five or six feet high. This rather exceeds the average height of the eye. There are various portable folding legs extant, but, on the whole, the folding legs with a triangular brass top, to which a flat disc of wood is attached, is worthy of most attention, on account of their rigidity, lightness, and compactness.

LENSES.

For landscape photography a single meniscus lens gives the most brilliant picture. It should be more rapid than doublets, as the loss of light from reflection by the surfaces is the least possible. For architectural subjects the doublet or triplet lens is necessary, as the single lens distorts marginal lines. For a complete outfit it is well to have four lenses:—(1) An ordinary single lens; (2) a wide-angle single lens; (3) a doublet lens; and (4) a wide-angle doublet. If only one lens can be provided, (3) should be chosen in preference to the others. For stereoscopic work the same applies. For portraiture a portrait doublet should invariably be used. By consulting a catalogue of some well-known maker, all information necessary for guiding the choice will be found.

English made lenses are, as a rule, recommended in preference to those of foreign make. They are more expensive, but are better finished, and are always achromatically corrected; that is, the chemical and visual foci are made to coincide. We recommend,

when using a camera in the field, that the cap of the lens be tied to the body of the lens by a loose string. This will prevent its loss, which so readily occurs when it is unconnected.

DROP SHUTTERS.

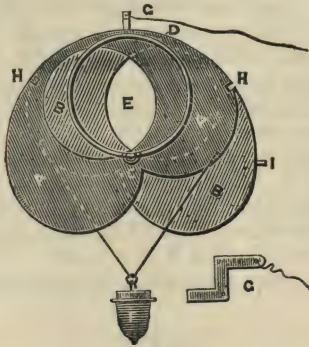
With the introduction of very rapid plates, some means of giving short exposures independently of the hand has become a necessity. Theoretically, the best place for these shutters is at the optical centre of the lens, or at its focus, since at either of these positions the image is cut off sharply at each part of the plate according as the shutter drops. In the photo-heliograph, for instance, a shutter is placed in this position, and there are no mechanical difficulties in the way of giving an exposure to each part of the plate, as small as 100th part of a second. Mr. England, in his instantaneous street views (better pictures than which there have never been), placed a drop shutter in front of the plate. For most cases, however, it will be found that if a shutter replace the cap of the lens a sufficiently short and sharp exposure may be given to each part of the sensitive plate. On p. 197 we have given shutters of two different descriptions, the latter (Colonel Wortley's) of which can be made by stout cardboard, a few lathes, and some wire, taking the precaution to blacken the inside when finished. In this shutter, the releasing pin might be done away with and a loop of cotton used for keeping the shutter in position before exposure. The loop could be cut by a pair of scissors, and then all fear of a jar at the commencement of exposure by pressure from the fingers on the pin would be avoided.

Mr. W. Bedford has introduced a drop shutter for instantaneous work which he described in the *Photographic Journal*.

The shutter is essentially constructed of two heart-shaped metal plates revolving on one axis, which is attached to the lower part of the mount of the lens. These two plates, when released by the trigger, have a reciprocal motion imparted to them by means of the weight which hangs suspended from the upper part of each. The apertures in each plate are thus simultaneously brought in front of the lens, and the exposure rapidly effected. AA, BB, are two similar metal discs pivotted at C; D is the ring adapter fitted to mount of lens; E is the centre of lens; F is a weight attached by silk cord to each disc; G is the trigger with cord attached, fitting into notches H. When the exposure is completed, the stop at I comes in contact

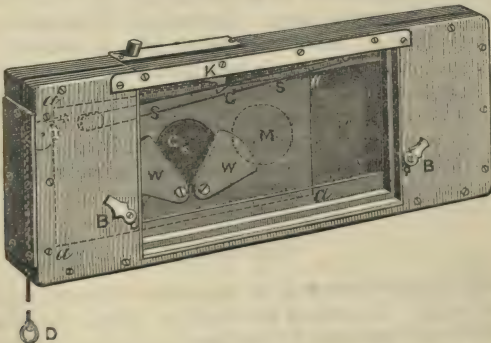
with an overhanging hook, near the trigger, which also serves to keep the discs in contact. The exposure commences and terminates at the lower side of the centre of the lens, so that the

Back View.



foreground gets slightly more light than the upper portion of the picture, an advantage which will be readily appreciated by most photographers. It will be seen that the exposure may be easily accelerated by diminishing the apertures.

The principle of Colonel Wortley's Instantaneous Shutter will be understood by a reference to the accompanying figure—



At the back of the narrow box in which the moveable parts are

situated is a projecting grooved piece (not shown), which replaces the ordinary camera front. In the opening of the box is fitted a board which carries the lens in the ordinary manner, and is fastened by BB. The lens occupies a position facing M, which is a circular aperture in the back of the box, and opening into the camera. *aaaa* is a rectangular sheet of brass in which a circular hole (C) has been drilled (of about the same diameter as M), and provided with two moveable wings, WW, by which it can be more or less closed, the sky in almost every case having less exposure given to it when the apparatus is used. In *aaaa* are two notches into which the ratchet (K) falls, K being raised when required by pressing down the thick pin shown on the top. One of the notches is seen at G, the other is so arranged that when K falls into it, C is exactly opposite M, in which position of the brass plate the usual focussing operations can be performed. An india-rubber band, SS (fixed as shown), pulls *aaaa* across the aperture M when K is released. The string D pulls back the sliding brass plate till K falls into one or other of the notches.

BATHS.

Porcelain baths answer well till the glaze gets cracked; they must then be put aside, or contamination of the bath solution may ensue. Glass baths in a wooden case with water-tight top are to be most recommended, as the solution can be inspected from time to time, also any accumulated dirt on the inside will be immediately noticed. One precaution should be observed in selecting glass baths, viz., to ascertain that the wooden case does not fit tightly on to the glass. The bottom of the case and its top should be padded all round with thick felt, to prevent breakage by any casual jar. Ebonite is brittle and injured by heat, but it may be used in a mild climate. It is well, however, to wash it thoroughly in potash and water, then rinse with distilled water, and finally to put an old bath solution in it to season it before taking it into permanent use. Gutta-percha is generally too impure a material to be substituted for glass.

DIPPERS.

Ebonite dippers answer in a temperate climate, and are not liable to break. A hook at the back to catch the edge of the bath, which just prevents it touching the bottom of the bath, is

an advantage. Any deposit thrown down is thus undisturbed. Makeshift dippers may be manufactured by cementing, with marine glue or bitumen, a small thick strip on to a long strip of glass. Silver wire dippers, perhaps, are the best, as there can then be no accumulation of the bath solution at the back of the plate.

DEVELOPING CUPS.

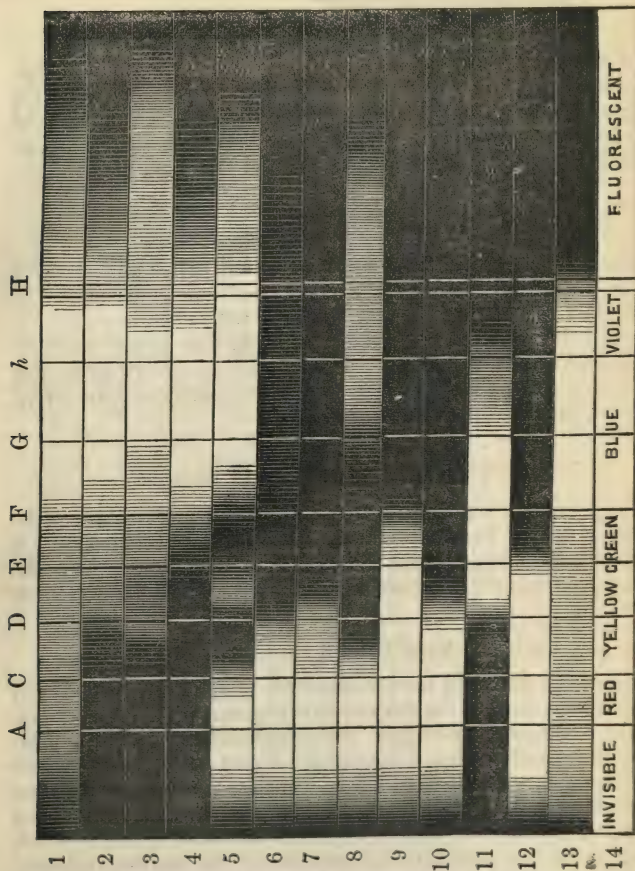
Glass developing cups are superior to any other, in that they can be kept clean, and the amount of solution in them can be accurately seen, which is not the case with ebonite cups. In the field it is useful to have a couple of the latter ready at hand in case of accidents. For plates up to 10 by 8, the children's small tumblers, sold for about a penny, answer every purpose, and they are difficult to break.

PNEUMATIC PLATE-HOLDERS.

There is no better plate-holder than the india-rubber globe pattern. It is convenient to have the globe enclosed in a cylindrical box open at the lower end. Remember to keep the plate-holder used for collodionizing the plate for that purpose alone.

LIGHT ADMISSIBLE IN THE DARK-ROOM.

It may be useful to the photographer to demonstrate the light that may be used in the dark room under varying circumstances. In the accompanying diagram the capital letters signify the principal Fraunhofer lines. Beneath are shown the different colours of the spectrum. The first four bands show the sensitiveness of various silver compounds to the different rays, the first being a specially prepared sample of silver bromide, which is not in general use, by which the absorptions of the various coloured media were photographed, as shown in the last nine bands. For silver bromo-iodide the stained red glass answers every purpose, and a dark room glazed with such may be flooded with such a light, and yet give freedom from fogged plates. For ordinary silver bromide there is no single glass which is absolutely safe, since ruby glass allows a small quantity of blue light to permeate. A combination of ruby and stained red glass will, however, be perfectly safe to use. Ordinary orange glass (flashed) should be avoided in all cases.



1, Special collodio-bromide; 2, gelatino-bromide; 3, collodio-bromide; 4, bromo-iodide; 5, cobalt glass; 6, ruby glass; 7, chrysoidine; 8, magenta; 9, flashed orange; 10, stained red glass; 11, bottle-green glass; 12, aurine; 13, quinine.

By coating a piece of glass or a lamp globe with aurine in varnish on one surface, and magenta in varnish on the other, the light transmitted may be almost entirely confined to the rays between A and C, or to only red light. Chrysoidine allows rays from A,

nearly as far as E, to penetrate, hence it is not a perfect protection. In glazing a dark room, strict attention must be paid to the aspect of the window, and to the films that are to be manipulated in it. For our own part, we prefer to work in a room of which the window is entirely darkened, and to use a lamp with a shade coated with the dyes named above, when preparing silver bromide films or developing the image impressed on them. An easy way to test the glass is to use a prism—such as a drop from a chandelier—and place the glass to be tested in a well-lighted window, or in front of a lamp, with a sheet of black paper behind it, with a central slit about $\frac{1}{8}$ inch wide cut in it to a height of about 1 inch. The prism is then brought close to the eye with the faces vertical, and the refracted image of the slit viewed through it. The light is then separated into its prismatic colours, and the parts of the spectrum absent can be easily noted.

NON-ACTINIC SCREENS.

A useful screen for developing dry plates at night by candle-light can be made as follows:—Take a sheet of cardboard of the size of about 2 feet by 1 foot 6 inches. Lay off from the 2 feet side distances of 8 inches from each corner, and with a penknife cut half through the card in a line parallel to the ends. These will form flaps, which can be folded round to meet, forming a hollow triangular prism. From the centre portion, and 6 inches from the bottom, mark out a square of 6 inches; cut round three of the sides, but only half cut through the bottom side, the penknife being applied from the inside of screen. This will allow a square flap to fold downwards towards the outside. On the inside of the opening may be pasted or hung two folds of paper, one dyed with magenta and the other with aurine; or sheets of gelatine (made by preparing a skin on a glass plate, as for heliotype—page 162—and dyeing it deeply with the above dyes) may be glued to it. The candle is enclosed by the screen, which will stand self-supporting in front of the operator. When packed for travelling the flaps are folded up, and it can be placed in the portmanteau with the greatest facility. For safety, it is perhaps advisable to blacken the inside of the cardboard.

EVAPORATING DISHES.

The best evaporating dish is made of platinum or silver.* A

* When a silver dish is used, no nitric acid must be added.

substitute for the latter is to use one thickly electro-plated. It lasts a long time, and is not a quarter the price. Berlin porcelain is generally used, but dishes made of this material should be at least six inches in diameter. A metal dish is superior, however, as it enables a solution to be evaporated to dryness without burning the residue or fusing portions whilst the remainder is still liquid.

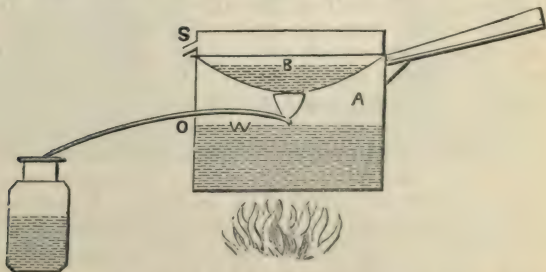
FUNNELS.

Ribbed glass funnels will be found better than those made with smooth glass, as the air which is displaced can, with the former, find a ready exit. Gutta-percha funnels should be used with caution, as it is impossible to ascertain if they are clean.

STILLS.

A still should be of a portable character. It should be ascertained that the worm of the condenser is not made of lead or any lead compound. The top of the still should be of such a shape that any water which may be projected upwards during ebullition is not able to travel down to the worm.

The following is a makeshift, which is in imitation of a well-known Indian contrivance. A is a saucepan of large size; B is the lid inverted. If a tinsmith be at hand, a spout, S, should be soldered into the lid, that the heated water in B may be changed with cold. A small hole is bored in the side of the



same pan at O, into which is fitted a tobacco pipe as shown in the figure. The surface of the water, W, is below the pipe. When the water boils the steam is condensed on B, trickles down to the tobacco pipe, and is collected at the other end of it. The

first pint of water distilled should be rejected, lest it be contaminated in any way.

The neatest arrangement for distillation, however, is with a Liebig's condenser where gas is available, as since glass alone is in contact with the liquid, there can be no danger of metallic impurity finding its way into the distillate.

DISHES.

Porcelain dishes are recommended in preference to any other kind. It is easily seen if they be clean, and they are easily scoured out after use. Ebonite dishes may be used for hyposulphite. They should be constantly cleaned from a deposit which forms on the bottom.

DRAINING BOXES.

A draining box which opens at the top and bottom is handy for outdoor work. For economy of space each pair of grooves should be capable of holding two plates back to back.

PACKING DRY PLATES.

To pack dry plates, resort may be had to the plan of separating one from the other by two strips of cardboard or thick paper bent zig-zag (as a hem is prepared for stitching), one at each end of the plate. Between each fold is placed a dry plate; the whole bundle should be bound round with twine, and wrapped in non-actinic coloured or opaque paper. A slightly different method is practised by Mr. Gordon and Mr. H. Cooper. Strips of cardboard a quarter inch wide and of the length of the plate are cut and glued on a piece of silk, strong muslin, or other flexible material about one-eighth of an inch apart. When dry, cut the cardboard along the centre, thus leaving pairs of strips of cardboard one-eighth inch wide glued on to flexible material. The space between the card should be equal to the thickness of two plates put back to back. To pack the plates, lay one on the table face up; then one of the card guards at each end; then on this a pair of plates back to back; then turn over the other part of the guard, and place two more plates, and so on, finishing with a single plate. The plates are then tied together and packed

in sheet gutta-percha, and next in tinfoil, though we have found that well varnished black paper answers in lieu of them both, if the packet be first wrapped in orange paper. It is necessary, however, when the parcel is broken into, to have some mode of storing the plates. This is best done by using a grooved box with a removable lid. The lid should slide into grooves, and lock; an inner loose lid, with a spring attached to its top, and strips of *unvulcanized* india-rubber placed across its ends, should rest on the edges of the plates. The spring is pressed down on the upper lid, and this presses on the plates, clamping them tightly together in position; two other strips are placed similarly on the inside of the bottom of the box, on which the plates rest. Each pair of grooves should hold two plates back to back. The whole of the inside of the box is usually lined with tinfoil; this allows dust to be got rid of, and prevents moisture permeating.

Another form of dry plate box is that introduced by Colonel Wortley, and certainly possesses some advantages. The bottom of the box and the top of the lid are fitted with quilted silk or fine calico, which firmly hold the plates. The arrangement for excluding light is also ingenious.

METHOD OF CARRYING NEGATIVES ON TOUR.

A tourist often finds the transport of any large quantity of glass in his travels a great source of discomfort, and to enable him to avoid it the following plan has been successfully followed by the writer. The method is one suggested by Mr. Walter Woodbury, in a brochure on the scenograph (see page 194). Originally it was intended to apply to emulsion plates, but the writer has found it equally adaptable to all kinds of collodion films. After a negative has been taken, fixed, and dried, a sheet of gelatinized paper (see page 170) is taken and immersed in cold water for a few seconds; the plate is placed beneath it, and the two are taken out of the water together as in the carbon development. The surfaces are brought in contact by a squeegee, and when the gelatine has sufficiently adhered, but is still damp, the film is stripped off. When dry, the paper is placed between the leaves of a blank book, and thus transported. The glass is of course serviceable for the preparation of other plates. To re-transfer the film to glass again, a plate of the proper size is flowed over with a solution of gelatine (1 ounce to 10 of water, to which 3

grains of chrome alum are added) and dried. The film with the paper is immersed in cold water, and the plate brought beneath it and squeegeed as before. This time they are allowed to dry thoroughly, after which they are immersed in hot water. The gelatine from the paper dissolves away, and leaves the film on the glass, which the insoluble gelatine retains. The process is simple, never failing with ordinary care, and the tourist will soon learn to appreciate its advantages.

APPARATUS FOR LONG TOURS:

The writer has often had queries put to him as to the size of apparatus most suitable for tours on the Continent and in hot climates. The reply is somewhat hard to make, as different conditions obtain in different countries.

For a Swiss tour, for instance, the writer would recommend a size of not more than 5 by 7, as in pedestrian excursions the photographer will be able to carry his own apparatus and concomitants. In India, on the other hand, where coolies may be hired to transport baggage for a small sum, a 10 by 8 camera will not be found too large. It should be recollected that a man cannot walk for any distance in a mountainous country with more than 16 pounds of extra weight on him, and this should regulate the size of the camera and amount of apparatus taken with the photographer who desires to be independent of guides and porters.

APPENDIX.

TO PURIFY WATER FOR PHOTOGRAPHIC PURPOSES.

The importance of using chemically fit water in photography is not to be over-rated. When distilled water cannot be obtained, resort must be had to purifying it to the best of our ability. The water should be roughly tested, to see what impurities it contains.

First add a drop of nitric acid to (say) one ounce of water; warm, and add a few drops of a solution of potassium sulphocyanide. A red colouration will show the presence of iron

sufficient to be injurious in making up a silver bath. Next add to a fresh portion a little ammonia and ammonium oxalate; a faint precipitate will show lime present to the extent of about six grains per gallon. This may be neglected. If more than a trace of precipitate be apparent, the water must be purified from the lime. Next boil the water. A precipitate will show that the lime is present as a bicarbonate; if not it is present as a sulphate. Magnesia is much less common in water than lime, and is present generally as sulphate (Epsom salts). Supposing all be present, and it is necessary to render them innocuous, we must proceed as follows:—First the water must be boiled, to get rid of carbonic acid, and to precipitate the carbonate from the bicarbonate of lime; this will leave about two grains per gallon of the calcium carbonate in solution. Next add ammonia till the water is slightly alkaline to test-paper. This will precipitate any iron present (probably present as carbonate), leaving carbonate of ammonia and a little free ammonia in solution. Boil the water again till all the ammonia is expelled. Next add a grain to the ounce of water of silver nitrate, and place it in a blue or white glass bottle in the sun. This will precipitate the carbonates and chlorides present, and also the organic matter. Next add a few drops of a solution of barium nitrate to precipitate the sulphuric acid that may be present in the sulphates, and filter. The water thus purified will make an excellent bath water. If water be only required for washing dry plates, &c., it should be boiled and passed through a charcoal filter, when it will be fit for use.

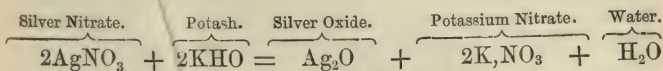
Rain-water should be passed twice through a charcoal filter to render it fit for use, that is, supposing it has been collected from the roofs of houses.

Water collected from snow is generally quite free from every hurtful impurity.

THE PREPARATION OF SILVER OXIDE.

If to a solution of silver nitrate a solution of potash be added, a precipitate will be formed. This is the silver oxide. The potash should be added till no further precipitation takes place. The oxide should be allowed to settle, when the supernatant fluid should be decanted off (a syphon arrangement is very convenient), and fresh distilled water added to it. This, in its turn, after the oxide has been well stirred, should be

decanted off. The operation should be repeated five or six times, until a drop of the water evaporated to dryness on a clean piece of platinum foil leaves no residue. The chemical reaction is as follows :—



The chief use of silver oxide is to neutralize a bath in which there is an excess of free acid, the nitric acid forming with it a fresh silver nitrate.

From this it is apparent that the oxide should be added till there is a slight deposit left.

The silver oxide is slightly soluble in water, hence on adding it to a bath solution it may be necessary to add a few drops of a dilute solution of nitric acid (one part of acid to 100 parts of water).

RAPID PREPARATION OF GELATINO-BROMIDE PLATES.

The writer has found that a great facility in obtaining density is secured by emulsifying rather more silver bromide in a given quantity of gelatine than is usually recommended. The formula employed is as follows:—Gelatine (Nelson's photographic) 40 grains. Water sufficient to cover it in a beaker.

The swelled gelatine is drained, and 60 grains of potassium bromide are added to it dissolved in 1 ounce of water, together with 10 grains of potassium nitrite, in order to counteract the retarding action of the potassium bromide. This is gently heated till the gelatine dissolves, when 80 grains of silver nitrate, dissolved in 1 ounce of water, are added in the usual manner. The emulsion may now be kept warm up to 90°, according to Mr. Bennett's plan, for any time that may seem best, and may be washed, if thought desirable, and allowed to set, and the plates treated with alcohol. It may then be re-dissolved and filtered, and when cooled to about 80° is ready for coating a plate. This is done in the usual manner, and the plate is laid upon a levelled shelf to set well. If the emulsion have not been washed, the plate, when the film is set, must be placed in a dish of water for a few minutes, to get rid of the excess of soluble salts, and then in a second dish for a few minutes more. It is next immersed in a bath of methylated spirits free from resinous

matter, and allowed to soak for half-an-hour, after which it is set up to dry in a cupboard. After half-an-hour's draining it may be placed in a hot-air oven, and in a quarter of an hour or so it will be ready for use. It is, however, preferable to let the plates dry spontaneously, as the gelatine is less liable to frill. This method of preparation is about the most rapid that can be adopted, and certainly the plates are very sensitive. It may pertinently be asked if there is any advantage in using an unwashed emulsion. If plates are required in a hurry, there evidently is an advantage, since the time expended in washing the pellicle is thereby gained. Another point, however, is this: if the emulsion be *kept* in an unwashed state, it does not readily decompose. When potassium bromide and silver nitrate are used, we have potassium nitrate left in the gelatine; as every one is aware, saltpetre preserves organic matter, hence it protects the gelatine in this case. It would seem that directly a plate is set, and washed in fresh water, if immersed in alcohol, the danger of the gelatine decomposing is very considerably reduced, and we can therefore hope that one source of annoyance in the preparation of such plates may be overcome.

In developing either by the alkaline or ferrous oxalate developer, the writer always uses a small quantity of soluble bromide. It may cause a necessity for a slightly longer exposure, but by its use there is certainly a gain in clearness.

TO PURIFY A BATH SOLUTION BY BOILING DOWN.

The bath should be placed in an evaporating dish, and be evaporated down to dryness, and fused till all the frothiness that may be apparent has subsided. It will be seen that the organic matter has reduced a portion of the silver nitrate to metallic silver. When sufficiently cool, add enough nitric acid and water, 1 of the former to 10 of the latter, to redissolve this by the aid of heat. Now evaporate to dryness. The nitrate should again be re-dissolved in ten ounces of water, and be once more evaporated to dryness, when it will be found that it is fit for making up to strength, all excess of acid being dissipated.

Boiling down a bath rids it of the alcohol and organic matter, but leaves the nitrates of cadmium, &c., unchanged. When surcharged with these latter, the silver should be precipitated.

NEW BATHS FROM OLD.

First Method.—Dilute the bath to twice its bulk, and filter out the iodide of silver which will be precipitated.

In the filtered bath solution place strips of copper or copper wire, and leave them undisturbed for twenty-four hours. This will throw down the silver in a metallic state, leaving the copper and other nitrates in solution. Take two or three drops of the *solution*, and test for the absence of silver by adding a little solution of common salt to them. If no white precipitate appear, the conversion into metallic silver is complete. Carefully decant the supernatant fluid, and withdraw all the copper visible; wash the silver in three or four changes of water until the blue colour due to the copper nitrate is absent; all the other salts will be washed away with the copper nitrate. Place the metallic silver in a large porcelain dish, and add *gradually* one drachm of pure nitric acid (1·36, the strength of the British Pharmacopœia) to every 150 grains of silver nitrate (this can be estimated by the argentometer) in the original bath solution. The silver will gradually dissolve, but will be much aided by the application of heat. The solution will now have a greenish colour, from small particles of copper which have fallen, coated with silver, from the original wires or strips. These small particles of copper will be dissolved by the nitric acid, and will form copper nitrate. Boil down the solution to small bulk—till it begins to spurt. This will free it from any great excess of nitric acid. Next add distilled water to it till it has a slightly larger bulk than it had before boiling down. Next add silver oxide, little by little, till the blue or greenish colour has entirely disappeared. This will precipitate the copper oxide from the copper nitrate, setting free the nitric acid, which, in its turn, will combine with the silver oxide. The copper will fall as a black powder mixed with any excess of silver oxide there may be. Take one or two drops of the solution in a measure, and add a drachm of water, and then add ammonia to it till the precipitate first formed is re-dissolved. If no blue colour is apparent, the substitution of the silver for the copper is complete; if not, more silver oxide must be added till the desired end is attained. Distilled water must next be added till the strength of the bath is that required. This can be tested by the argentometer. An emulsion of silver iodide *may* here appear. If it do, no matter. When the solution is filtered

the bath is fit for use, being chemically pure, neutral, and charged to a proper extent with iodide of silver.

Second Method.—Dilute and filter the bath as in the first method, and place in the solution strips of zinc. The silver will precipitate, as with the copper; small particles of zinc will also fall with the silver, and must be got rid of. This may be done by two methods—either by dilute hydrochloric acid, or dilute sulphuric acid (one part of acid to twelve parts of water). The silver is collected from the solution either by filtration or decantation, and is well washed. It is then placed in a porcelain dish, and is boiled with the very dilute acid (about one part to one hundred of acid). This dissolves the zinc, and only slightly attacks the silver. The mass is thrown on the filter, and washed well with boiling distilled water. If sulphuric acid have been used, this washing dissolves out any silver sulphate which may have been formed. The silver is dissolved up by nitric acid as in the first method. If hydrochloric acid have been used, there will remain a little silver chloride, which will be filtered out.

TO MAKE SILVER NITRATE.

Silver coins are mostly alloyed with tin or copper. In both cases the coin should be dissolved in nitric acid diluted with twice its bulk of water. If tin be present there will be an insoluble residue left of stannic oxide. The solution should be evaporated down to dryness, re-dissolved in water, filtered, and again evaporated to dryness. It will then be fit for making up a bath. If copper be present, the solution must be treated as given in the last article, where the oxide silver is substituted for copper oxide.

EASY TESTS FOR THE AMOUNT OF SILVER NITRATE IN A SOLUTION.

Take half an ounce of the solution to be tested, and precipitate the silver as chloride by adding a slight excess of hydrochloric acid or common salt. Filter the solution off, and dry the filter paper and the chloride over a water bath. The chloride can then be easily removed from the filter paper, and should be weighed. The weight multiplied by 1.18 will give the amount of silver nitrate.

Another very pretty method is as follows:—Measure with a *

pipette (or dropping-bottle) one hundred drops of the solution to be tested; rinse the pipette, and drop from it, into the silver solution, a solution of dried salt and water (thirty-five grains to the ounce), till no more precipitate of silver chloride is seen to form. The number of drops added to the silver solution will be the number of grains of silver nitrate in the ounce of bath.

There are two methods of ascertaining when no further precipitate is formed: first by adding a drop of potassium chromate (*not bichromate*) to the salt solution, and noting when the precipitate finally has a permanent red tinge after stirring; or the solution of salt may be placed in a stoppered bottle, and be shaken between each addition of the silver. The silver chloride agglutinates by shaking, and a fresh precipitate is seen to form at once on adding another drop of silver. When all the sodium chloride is precipitated, the solution remains milky.

UTILIZATION OF SILVER RESIDUES.

All paper or solutions in which there is silver should be saved, as it has been proved by experience that from 50 to 75 per cent. of the whole of the silver used can be recovered by rigid adherence to the careful storing of "wastes."

1. All prints should be trimmed, if practicable, before toning and fixing; in all cases these clippings should be collected. When a good basketful of them is collected, these, together with the bits of blotting-paper attached to the bottom end of sensitized paper during drying, and that used for the draining of plates, should be burnt in a stove, and the ashes collected.* These ashes will naturally occupy but a small space in comparison with the paper itself. Care should be taken that the draught from the fire is not strong enough to carry up the ashes.

2. All washings from prints, water used in the preparation of dry plates, all baths, developing solutions (after use), and old toning baths, should be placed in a tub, and common salt added. This will form silver chloride.

3. The old hyposulphite baths used in printing, and the solutions of cyanide of potassium, or sodium hyposulphite, used for fixing the negatives, should be placed in another tub. To

* In large establishments the films from rejected negatives may be added.

this the potassium sulphide of commerce may be added, or else a stream of sulphuretted hydrogen passed through it till no more precipitation takes place. Silver sulphide is thus formed.

4. To No. 1 nitric acid may be added, and the ashes boiled in it till no more silver is extracted by it. The solution of silver nitrate thus produced is filtered off through white muslin, and put aside for further treatment.

5. The ashes may still contain silver chloride. This may be dissolved out by adding a solution of sodium hyposulphite, and adding the filtrate No. 3.

6. The solution from No. 4 may next be evaporated to dryness, and crystals of silver nitrate be produced; or else common salt may be added, and the precipitate added to No. 2.

7. No. 2, after thoroughly drying, may be reduced to metallic silver in a reducing crucible* by addition of two parts of sodium carbonate and a little borax to one of the silver chloride. These should be well mixed together, and placed in the covered crucible in a coke fire, and gradually heated. (If the operator be in possession of one of Fletcher's gas furnaces, page 180, he can employ it economically, and with far less trouble than using the fire. It is supplied with an arrangement for holding crucibles, which is useful for the purpose.) After a time, on lifting off the cover, it will be found that the silver is reduced to a metallic state. After all conflagration has finished, the crucible should be heated to a white heat for a quarter of an hour. The molten silver should be turned out into an iron pan (previously rubbed over with plumbago to prevent the molten metal spirting), and immersed in a pail of water. The washing should be repeated till nothing but the pure silver remains.

8. The chloride may also be dissolved in sodium hyposulphite, and added to 3.

The silver hyposulphite, having been reduced to the sulphide by the addition of the potassium sulphide, is placed in a crucible and subjected to a white heat; the sulphur is driven off, and the silver remains behind.

9. A last method is that of treating the whole of the residues as hyposulphite. A sheet of zinc is placed in the tub, and the silver is precipitated in a metallic state. The supernatant liquid

* The crucible should be of Stourbridge clay.

is syphoned off, and replenished from the other waste solution. When the amount of silver deposited is sufficient, it is filtered out through fine calico and collected. After thorough washing it should be heated, to drive off the large amount of sulphur which is collected, and may be treated with nitric acid to form silver nitrate, or else be melted in a crucible with borax to form an ingot. If the plan be adopted of forming silver nitrate, the small amount of gold present will be left behind as a grey powder. This, after being well washed, may be treated with nitro-muriatic acid, as given below, and re-converted into trichloride. There will always be a certain amount of silver sulphate formed from the action of the nitric acid on the sulphur deposited with the silver.

Another method of reducing silver chloride to the metallic state is by placing it in water slightly acidulated with sulphuric acid together with granulated zinc. The zinc is attacked, evolving hydrogen, which in its turn reduces the silver chloride to the metallic state, and forming hydrochloric acid. After well washing, the silver may be dissolved up in nitric acid.

Yet another method is to take sugar of milk and a solution of crude potash, when the silver is rapidly reduced. This requires careful washing, and it is well to heat the metal to a dull red heat to get rid of any adherent and insoluble organic matter which may have been formed, before dissolving it in nitric acid.

TO MAKE GOLD TRI-CHLORIDE [Au Cl_3].

Place a half-sovereign (which may contain silver as well as copper) in a convenient vessel; pour on it half a drachm of nitric acid, and mix with it two-and-a-half drachms of hydrochloric acid; digest at a gentle heat, but do not boil, or probably the chlorine will be driven off. At the expiration of a few hours add a similar quantity of the acids. Probably this will be sufficient to dissolve all the gold. If not, add acid the third time; all will have been dissolved by this addition, excepting, perhaps, a trace of silver which will have been deposited by the excess of hydrochloric acid as silver chloride. If a precipitate should have been formed, filter it out, and wash the filter paper well with distilled water. Take a filtered solution of ferrous sulphate (eight parts water to one of iron) acidulated with a few drops of hydrochloric acid, and add the gold solution to it; the iron will cause the gold alone to deposit as metallic gold, leaving the

copper in solution. By adding the gold solution to the iron the precipitate is not so fine as if added *vice versa*. Let the gold settle, and pour off the liquid; add water, and drain again, and so on till no acid is left, testing the washings by litmus paper. Take the metallic gold which has been precipitated, re-dissolve in the acids as before, evaporate to dryness on a water bath that is at a heat not exceeding 212° F. The resulting substance is the gold tri-chloride. To be kept in crystals this should be placed in glass tubes hermetically sealed. For non-commercial purposes it is convenient to dissolve it in water (one drachm to a grain of gold). Ten grains of gold dissolved yield 15.4 grains of the salt. Hence if ten grains have been dissolved, 15.4 drachms of water must be added to give the above strength.

TO OBTAIN ALCOHOL FROM SPIRITS OF WINE.

Take ordinary chalk, and burn it thoroughly in a crucible, expelling all the carbonic acid. This product will be quicklime. Add this to the spirit of wine to be rectified, and leave it in a tightly-corked bottle for three or four days. The quicklime will absorb the water, leaving the alcohol nearly anhydrous; the alcohol, with the quicklime, may now be transferred to a glass flask and be distilled over. This gives absolute alcohol of 0.794. Quicklime fresh from the kiln is equally effective.

If dry potassium carbonate be used instead of lime (see next article), and the distillation takes place, the resulting strength of alcohol is about .814.

TESTING FOR THE AMOUNT OF WATER IN ALCOHOL.

Take a small quantity of chloroform and pour it into a graduated test tube. Add to it a given quantity of the alcohol to be tested. Shake up both well together. On settling, the water will have combined with the chloroform, and the difference in volume may be read off the test tube.

Another method is to add an *excess* of dry carbonate of potash to a given quantity, and then to read off the amount of fluid left, calculating it as of .814 sp. gr. This obtains on account of the insolubility of the carbonate in alcohol and its affinity for water.

TESTING FOR METHYLATED ALCOHOL.

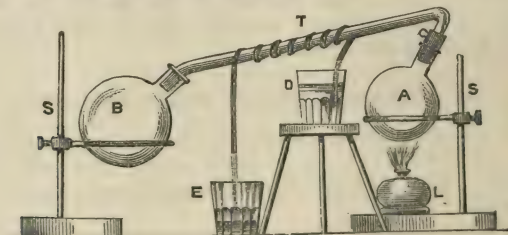
If a small quantity of caustic potash be added to alcohol suspected of being methylated, the presence of the impurity will be indicated by a brownish tint being given to the liquid.

PREPARATION OF PLATINUM TETRA-CHLORIDE [Pt Cl₄].

Take any old scraps of platinum foil or wire, and having cleaned them with boiling nitric acid, place them in a porcelain dish containing aqua regia (four parts of hydrochloric to one of nitric acid). By the aid of heat this will cause a solution of platinum tetra-chloride to be formed. The solution is evaporated nearly to dryness, or until it becomes viscous. It is then re-dissolved in water, and evaporated to the same state once more. For photographic purposes, this may be redissolved again in distilled water of the strength of one grain of the tetra-chloride to one drachm of water. It should be remembered that every 10 grains of platinum yield 17·2 grains of the tetra-chloride; hence with every ten grains of platinum dissolved, 17·2 drachms of water must be added to make it of the above strength.

TO MAKE A STILL FOR DISTILLING ALCOHOL.

The accompanying diagram shows the method for forming a rough still, but one which is perfectly adapted for small distillation. A and B are two Florence flasks, supported as shown by two supports; S S earring rings. In the neck of A is fitted a perforated cork, C. A piece of quarter-inch soft glass tubing is bent in a common gas flame, and fitted into the cork,



the long arm sloping slightly downward. Two tumblers, D and E, are placed in position as shown. D is filled with water, and from it is carried a length of tow. This is wrapped round and round the tubing, and the other end is allowed to hang over E. Capillary attraction will cause the water to be carried round the tubing by the tow; this will ensure the latter always being cooled. Into the flask A is poured the liquid to be distilled, and a spirit lamp, L, is placed below it. The

vapour passes into the tube T, where it is condensed, and passes into B. To prevent the water running down T from the tow, a small india-rubber band should be made to fit tightly round the tube, a small pin inserted at the bottom to take off the drops. It is a more convenient arrangement to have a proper Liebig's condenser. This may be formed by encasing the glass tube in a larger tube having a small tube to which india-rubber tubing can be attached to it at the bottom end, and a similar overflow tube at the top. Cold water is poured from a supply raised above the apparatus by means of the india-rubber tubing, and forces out the warm water from the top. The larger glass tube may be fitted with corks at each end, through which holes may be cut to admit the glass tube. This plan will be found of use for distilling alcohol or collecting the solvents from old collodion.

TO RECOVER ETHER AND ALCOHOL FROM OLD COLLODION.

Add to the collodion a little potash to neutralize all acidity, and also a small piece of metallic zinc. This will cause the iodine to form zinc iodide.

The solution may now be distilled over as given above, taking the precaution to fit a cork (through which a safety tube should pass to the bottom of the flask) into the bottle into which the condensed vapours pass.* The solvents may be used for fresh pyroxyline.

TO PREPARE ALBUMEN FOR SUBSTRATUM.

Place the albumen in a mortar with a little silica or fine *white* sand, and grind it till it is perfectly even. Next add the water required. This method may be substituted for that given previously.

TO DECOLOURIZE COLLODION.

Add to the collodion small strips of metallic cadmium, zinc, or silver, and shake well. With the first two metals the iodide formed will be dissolved by the collodion solvents. With the last the iodide will remain at the bottom of the bottle, except that part dissolved by the other soluble iodides.

* The flask should be heated by hot water till all the ether is distilled; if by the naked flame, the ether vapour is given off too energetically.

TO CLEAN THE HANDS FROM SILVER AND IRON STAINS.

Take hydrochloric acid and dilute it to half its strength ; or, better still, chloride of lime in strong solution. Pour a quarter of an ounce of this on the hands, and rub well in till the stains disappear. Iron stains may still remain of a greenish tint. *Rinse the hands*, and apply a little dilute solution of potassium oxalate. The hands will be found free from stains. This method avoids the use of potassium cyanide or sodium hyposulphite. Chlorides of the alkalis are sometimes recommended in lieu of the hydrochloric acid. They are not so effective. The hydrochloric acid does not discolour the hands permanently. The alkaline solution in any case restores the tissues to their proper colour. After alkaline development the stains may be got rid of by oxalic acid. In all cases potassium cyanide will be effective. This should only be used with excessive caution, on account of its poisonous character. Its free use is apt to cause a species of paralysis.

TO TAKE SILVER AND IRON STAINS, ETC., OUT OF LINEN.

The same procedure as above is effective : iron and silver are converted into chloride, and pyrogallie acid is decomposed by the acid. The iron washes out, and the chloride of silver is afterwards dissolved by the ammonia.

To take stains out of cloth the same method may be tried, but it is rarely completely successful by any method, as the dye will be attacked by the acid. Potassium cyanide applied with soap may be tried, but it often leaves stains caused by the mordant of the dye.

GROUND GLASS AND ITS SUBSTITUTES.

When the ground glass of the camera has been broken, circumstances sometimes prevent it being replaced by a purchased article. The following method will give a substitute for it :—

Take a piece of glass of the size to be ground. Lay it flat on a board or table, sprinkle the finest emery over the surface, and moisten it. With another small piece of glass grind it smoothly and evenly till a uniform grain is apparent over the whole surface. The finer the emery the finer will be the resulting

grain. A substitute for ground glass may be produced by sensitizing a plate as usual, exposing and developing till there is a fair deposit on the film (if the developer be acidified with nitric acid in lieu of acetic acid, the silver will be deposited in a white form); use the silver as the ground surface of the glass. White wax dissolved in ether, and flowed over the plate as in mounting transparencies (see page 115), gives the finest surface possible on which to focus.

TO MIX SOLUTIONS CONTAINING GUM.

It is often necessary to mix at a short notice solutions containing gum. The gum should be pounded to powder in a mortar, and warm water added to it. It is easily filtered through "papier Joseph." On no account should a flask containing undissolved gum be placed over a naked flame, or the gum will then become decomposed. An enamelled glue-pot is very useful for preparing gum solutions, the temperature of boiling water being thus never exceeded. Should gum be acid, it may be neutralized with lime-water. Lime-water is formed by placing a piece of burnt lime the size of a nut in a pint of water.

PURIFYING PRINTING BATHS.

The ordinary method of purifying a printing bath from the albuminate formed is to add a small quantity of pure kaolin, then to shake it up and filter. This method answers perfectly, but is rather wasteful.

If the bath be rendered quite neutral to litmus paper, and be placed in the sun, the organic matter is deposited together with the silver oxide, and the solution rendered pure.

If a small quantity of sodium chloride (common salt) be added, it will be found, on shaking up the silver chloride formed, that the organic matter is deposited with the chloride, and can be separated by filtration. A small quantity of saturated solution of camphor in alcohol will answer the same purpose.

The addition of a sodium carbonate answers equally well, and may be used with advantage. It is generally advisable to have a small quantity of the carbonate of silver at the bottom of the bottle, as by so doing, the neutral condition of the bath is ensured, and the organic matter is continually being deposited.

TO INTENSIFY A NEGATIVE AFTER VARNISHING.

A negative may be rendered more intense after varnishing by adding iodine to the varnish till it assumes a light port wine colour, and re-varnishing with this solution in the ordinary manner.

TO INTENSIFY A NEGATIVE BY THE ACTION OF LIGHT.

If, after developing, the negative be well washed, and exposed to sunlight till the unaltered silver salts assume a brownish colour, the intensity of the negative will be found to be materially increased.

A SIMPLE METHOD OF ADDING EXTRA BROMIDE TO A COLLODION.

Dissolve eighteen grains of bromide in an ounce of collodion. The addition of a drachm of this to each ounce of the collodion will give (very nearly) an extra two grains of bromide.

TO RETOUCH VARNISHED NEGATIVES.

To retouch negatives a blacklead pencil is found to give the best results (B answers well). When varnished the negative requires a "tooth" given it to take the pencil. This is best obtained by taking *very finely powdered* resin, and rubbing it gently over the part required to be retouched. Finely-powdered pumice may be substituted for the resin.

If a negative be varnished without heat, a sufficient tooth will also be given; but great care is required, in re-varnishing it, to preserve the blacklead from running. In this case the second coating of varnish should be applied cold, and the plate be afterwards well heated.

TO BEND GLASS TUBING.

Ordinary glass tubing can be bent by simply placing the part where the curve is required in the flame of a spirit lamp, or in an ordinary gas flame. The tube should be held by the two hands, and turned round between the fingers, so that the whole of the surface to be acted upon gets equally heated. When the glass feels softened, a gentle pressure by the hands will give the necessary bend. If the heated surface be small, the tubing will not remain circular in section at the bend, but will be flattened.

TO MAKE A SYPHON.

Bend a piece of tubing so as to form two legs nearly parallel; pierce a cork with two holes, and in one fit tightly one leg of the bent tubing, and in the other fit in a piece of straight tubing. To use the syphon, if the cork fit the bottle, press it tightly into the neck; or if it be larger, press it firmly on to its lip. See that the straight tube is above the level of the liquid, whilst the leg is well in it. Blow down the former till the liquid rises past the bend of the latter, when a constant flow will result, till the level of the inner or outer leg (according to which is the higher of the two) is reached.

TO REMOVE THE VARNISH FROM A NEGATIVE.

Varnish may be removed from a negative by warming it gently, and applying spirits of wine to its surface *gently*. The spirit must be poured off, the plate re-heated, and a fresh quantity applied as before. This operation must be continued till the varnish appears to be totally dissolved from the surface of the negative. Alcohol vapour made by heating spirits of wine over a spirit lamp in a test tube is very rapid in its solvent action. A final rinse of spirits should, however, always be given. A moderately strong solution of caustic potash will also remove most varnishes, and is recommended as simpler than the first method.

CONVENIENT DROPPING BOTTLES.;

A convenient dropping-bottle may be formed with any ordinary four or six-ounce bottle by cutting a slot in the cork from end to end, and fixing it in the bottle in the ordinary manner. If this and an ordinary cork be attached to the neck of the bottle by twine, the two may be interchanged as required.

TO TEST FOR IRON IN A FILTER PAPER.

Moisten the filter paper with a drop or two of hydrochloric acid. Then add a drop of ferricyanide of potassium to the moistened part. A blue stain will show the presence of sufficient iron to be injurious to a bath solution.

SILVERING MIRRORS.

All the following chemicals must be absolutely pure to ensure success.

The following is the formula given by Martin:—

No. 1.—Silver nitrate	...	...	17.5 grains
Water (distilled)	...	...	1 ounce
No. 2.—Ammonium nitrate	...	...	26.25 grains
Water (distilled)	...	...	1 ounce
No. 3.—Caust. pot. free from Cl and CO ₂	...	...	44 grains
Water (distilled)	...	...	1 ounce

No. 4.—Dissolve 440 grains of sugar in 10 ounces of distilled water, add 53 grains of tartaric acid, and boil for ten minutes. Next add 2 ounces of alcohol, and add sufficient water to make up to 20 ounces if the silvering is to be done in winter, or to more if it is to be done in summer.

The effect of tartaric acid on the sugar is to produce inverted sugar, which reduces the silver from the mixed solutions.

In our own practice we use about 31 grains of ammonium nitrate, instead of 26.25 grains, the crystals being dried beforehand.

The plate is cleaned with concentrated nitric acid, by the aid of cotton wool, perfectly free from all extraneous matter (see page 7). It is then washed in distilled water, and dried. Equal parts of No. 3 and alcohol are next applied, and whilst still wet the plate is placed in distilled water, and all the alkali rubbed off by a badger-hair brush. The plate is finally placed face downwards in distilled water, resting on a couple of *clean* strips of glass.

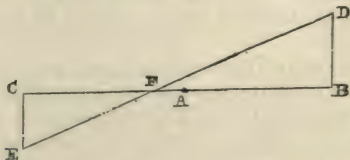
To prepare the silvering solution, equal parts of Nos. 1 and 2 are mixed in one measure, and the same quantities of 3 and 4 in another. The mixture in the second measure is poured into the first measure, and after thoroughly stirring the whole is transferred into a dish. The quantity should be so arranged that the solution just covers the bottom surface of the plate to be silvered when resting upon wedges (wooden ones covered with india-rubber solution will answer) about a quarter of an inch in height. The solution being poured in, the plate is placed on the silver. If the mixture becomes blackly turbid at once, it is probable there is not enough of No. 2 present; whilst if it remain clear for two or three minutes, there is probably an excess. When the solution turns inky black the silvering com-

mences, and the dish should then be rocked slightly for about five or ten minutes, when, if correctly made up, the solution should become clear, and flakes of silver float up to the top. The glass will now be covered with a coating of silver, and it should appear perfectly bright if the chemicals are *pure*, and if the plate has not been left too long in the solution. The deposit should be very nearly opaque; any light passing through should be of a deep indigo colour. There is often a little bloom on the surface, which, when the surface is dried, can be removed by a tuft of cotton wool. A surface which is slightly matt can be polished by a pad of *fine* chamois leather and a little jeweller's rouge. The pad should be warmed, and the polishing done with a light hand. A green tint in the deposit indicates defective cleaning of the plate, whilst a purple tint indicates something wrong in the solutions.

TO FIND THE EQUIVALENT FOCUS OF A LENS, AND ITS DISTANCE FROM AN OBJECT FOR ENLARGING, ETC.

The equivalent focus of a lens is a term applied to a compound lens. It is the focus of parallel rays entering the lens. It is termed "equivalent" from being compared with a single lens that would produce the same sized image at the same distance from the object.

Measure a distance of (say) one hundred and fifty feet away from some fixed point, and place a rod at one extremity. From this point measure a line exactly at right angles to the first, of



some forty feet in length, and place another rod at its other end. Now place the front of the camera exactly over the starting point of the first line and level it, the lens being in the direction of the first line. Having marked a central vertical line on the ground glass with a pencil, focus the first rod accurately, so as to fall on the pencil line on the ground glass. Take a picture of the two rods in the ordinary way, and measure back as accu-

rately as practicable the distance of the centre of the ground glass from the starting point, and also the distance apart of the two images of the rods (at their base) upon the negative.

Suppose the first measured line, AB to be 149 feet; BD, the second line, to be 35 feet; AC to be 1 foot; and EC, the distance apart of the two images, to be 3 inches, F being the point where DE cuts CB.

Then $BD+CE : CB :: CE : CF$, which is the equivalent focal distance.

Here, $CB=150$ ft. $BD+CE=35\cdot25'$ ft. $CE=.25$ ft.

$$\therefore CF = \frac{150 + \cdot25}{35\cdot25} = 1\cdot063 \text{ ft.}$$

This gives the equivalent focal distance, which is the distance of the ground glass from the optical centre. Having taken the thickness of the ground glass previously, the distance may be set off from its smooth side on to the brass work of the lens by a pair of callipers. This point (the optical centre) having once been obtained, its position should be marked on the brass work, and from it all measurements should be calculated. This method is *very nearly* mathematically accurate. Were the distance taken of shorter length than those given, an appreciable error might be found. At the distance given the rays of light entering the lens from the rod are virtually parallel, and thus fulfil the necessary conditions. It must also be remarked that the distance AB being so great in comparison with AC as that any slight error in the back measurement will affect the result by an inappreciable quantity, CE should be measured most accurately from the negative. The mean of a series of trials should be taken.

Having obtained the equivalent focal distance of the lens, the respective distance of the object and ground glass from the optical centre can be obtained by the following formula:—

$$v = \frac{f(n+1)}{n} \text{ and } u = nv$$

where v is the distance of the focussing screen, u that of object from the optical centre, n being the linear reduction, or enlargement.

On the following page is a table of enlargement or reduction for lenses with certain equivalent focal distances.

TABLE OF ENLARGEMENT OR REDUCTION.

Equivalent Focus of Lens.	Reduction.	Enlargement or Reduction.						Enlarge- ment.	Remarks.
		1	2	3	4	5	6		
6"	<i>u</i>	12	18	24	30	36	42	<i>v</i>	<i>v</i> =distance of image on ground glass, and <i>u</i> =dis- tance of the ob- ject from the centre.
	<i>v</i>	12	9	8	$7\frac{1}{2}$	$7\frac{1}{6}$	7	<i>u</i>	
$6\frac{1}{2}$	<i>u</i>	13	$19\frac{1}{2}$	26	$32\frac{1}{2}$	39	$45\frac{1}{2}$	<i>v</i>	
	<i>v</i>	13	$9\frac{3}{4}$	$8\frac{2}{3}$	$8\frac{1}{8}$	$7\frac{4}{6}$	$7\frac{7}{12}$	<i>u</i>	
7	<i>u</i>	14	21	28	35	42	49	<i>v</i>	
	<i>v</i>	14	$10\frac{1}{2}$	$9\frac{1}{3}$	$8\frac{3}{4}$	$8\frac{2}{6}$	$8\frac{1}{6}$	<i>u</i>	
$7\frac{1}{2}$	<i>u</i>	15	$22\frac{1}{2}$	30	$37\frac{1}{2}$	45	$52\frac{1}{2}$	<i>v</i>	
	<i>v</i>	15	$11\frac{1}{4}$	10	$9\frac{3}{8}$	9	$8\frac{3}{4}$	<i>u</i>	
8	<i>u</i>	16	24	32	40	48	56	<i>v</i>	
	<i>v</i>	16	12	$10\frac{2}{3}$	10	$9\frac{3}{6}$	$9\frac{1}{6}$	<i>u</i>	
$8\frac{1}{2}$	<i>u</i>	17	$25\frac{1}{2}$	34	$42\frac{1}{2}$	51	$59\frac{1}{2}$	<i>v</i>	
	<i>v</i>	17	$12\frac{3}{4}$	$11\frac{1}{3}$	$10\frac{2}{6}$	$10\frac{1}{6}$	$9\frac{7}{12}$	<i>u</i>	
9	<i>u</i>	18	27	36	45	54	63	<i>v</i>	
	<i>v</i>	18	$13\frac{1}{2}$	12	$11\frac{1}{4}$	$10\frac{7}{6}$	$10\frac{1}{2}$	<i>u</i>	
$9\frac{1}{2}$	<i>u</i>	19	$28\frac{1}{2}$	38	$47\frac{1}{2}$	57	$66\frac{1}{2}$	<i>v</i>	
	<i>v</i>	19	$14\frac{1}{4}$	$12\frac{2}{3}$	$11\frac{3}{8}$	$11\frac{2}{6}$	$11\frac{1}{12}$	<i>u</i>	
10	<i>u</i>	20	30	40	50	60	70	<i>v</i>	
	<i>v</i>	20	15	$13\frac{1}{3}$	$12\frac{1}{2}$	12	$11\frac{2}{3}$	<i>u</i>	
$10\frac{1}{2}$	<i>u</i>	21	$31\frac{1}{2}$	42	$52\frac{1}{2}$	63	$73\frac{1}{2}$	<i>v</i>	
	<i>v</i>	21	$15\frac{3}{4}$	14	$13\frac{1}{6}$	$12\frac{3}{6}$	$12\frac{1}{4}$	<i>u</i>	
11	<i>u</i>	22	33	44	55	66	77	<i>v</i>	
	<i>v</i>	22	$16\frac{1}{2}$	$14\frac{2}{3}$	$13\frac{3}{4}$	$13\frac{1}{3}$	$12\frac{5}{6}$	<i>u</i>	
$11\frac{1}{2}$	<i>u</i>	23	$34\frac{1}{2}$	46	$57\frac{1}{2}$	69	$80\frac{1}{2}$	<i>v</i>	
	<i>v</i>	23	$17\frac{1}{4}$	$15\frac{1}{3}$	$14\frac{3}{8}$	$13\frac{4}{6}$	$13\frac{5}{12}$	<i>u</i>	
12	<i>u</i>	24	36	48	60	72	84	<i>v</i>	
	<i>v</i>	24	18	16	15	$14\frac{2}{3}$	14	<i>u</i>	

Applying this table to an example:—Suppose the equivalent focal distance of the lens to be $9\frac{1}{2}$ ", and that it is desired to

water, and deduct the weight formed from the original quantity. This gives the amount of calcium carbonate converted into calcium nitrate.

The combining weight of calcium carbonate $\text{CaCO}_3 = 100$

nitric acid $\text{HNO}_3 = 63$

Then $100 : 63 :: \text{weight of lime dissolved} : \text{nitric acid}$.

Note.—At 60° F . nitric acid of 1.457° specific gravity contains 79 per cent. of nitric acid, and at 1.420 , 69.20 per cent.

These specific gravities are those mentioned in the work.

DETERMINATION OF THE STRENGTH OF SULPHURIC ACID.

This cannot be determined by calcium carbonate, as the calcium sulphate is moderately soluble in water; in this case recourse may be had to taking a fixed quantity of the acid as before, and precipitating it with barium chloride, forming insoluble barium sulphate, which, after washing, is weighed. Taking the combining weight as before—

$230 : 98 :: \text{weight of precipitate} : \text{sulphuric acid } (\text{H}_2\text{SO}_4)$

Note.—At 60° Fah . sulphuric acid of 1.840 contains 97 per cent. of H_2SO_4 .

HOW TO CALCULATE THE AMOUNT NECESSARY TO FORM A COMPOUND FORMED BY DOUBLE DECOMPOSITION.

The writer has had many enquiries regarding the method of calculating the amount of silver nitrate to be added to a soluble bromide in order to just convert all the bromine of the latter into silver bromide. He therefore takes this opportunity of working out some examples, on the lines of which any other compound may be calculated.

How many grains of silver nitrate must be added to twenty grains of zinc bromide to convert the bromine in the latter to silver bromide?

From the table of combining weights, it will be seen the combining weight of Zn is 65.2, of Br 80, of Ag 108, of N 14, of O is 16.

Since Zn combines with two equivalents of Br, the formula for zinc bromide is Zn Br_2 , hence its combining weight is $65.2 \times 2 + 80 = 225.2$. The formula for silver nitrate is Ag NO_3 , hence its combining weight is $108 + 14 + 3 \times 16 = 170$.

Now as in each molecule of zinc bromide there are two atoms of bromine, and in each molecule of silver nitrate one atom of silver, in order to form silver bromide, which is Ag Br (since Ag combines with one atom of Br) two molecules of silver nitrate

must be brought in contact with one molecule of zinc bromide. We can, therefore, form a simple rule-of-three sum—

Combining weight of Zinc Bromide.	Twice the combining weight of Silver Nitrate.	Grains of Zinc Bromide.	Grains of Silver Nitrate.
225·5	2×170	20	x

When worked out the answer is 30·2 grains of silver nitrate.

How many grains of silver nitrate are required to be added to fifteen grains of sodium chloride, in order that all the chlorine in the latter may be in combination with silver?

As before, the combining weight of silver nitrate is 170, of sodium chloride 58·5, for since sodium is a monad, its formula is Na Cl. Since there is only one atom of chlorine in each molecule of sodium chloride, we do not double the combining weight of the silver nitrate, and we get—

Combining weight of Sodium Chloride.	Combining weight of Silver Nitrate.	Grains of Sodium Chloride.	Grains of Silver Nitrate.
58·5	170	15	x

when worked out, x becomes 45·6 nearly.

How many grains of silver nitrate and potassium iodide must be used to form thirty grains of silver iodide?

The combining weights of silver iodide, potassium iodide, and silver nitrate are arrived at as before, and are 235, 166·1, and 170, respectively. We proceed exactly as before: 1st. We will find the amount of potassium iodide—

Combining weight of Silver Iodide.	Combining weight of Potassium Iodide.	Grains of Silver Iodide.	Grains of Potassium Iodide.
235	166·1	30	x

or $x = 21·2$ grains of potassium iodide.

Similarly, by substituting 107 for the 166·1 in the above, we should find that the amount of silver nitrate to be used in forming thirty grains of silver iodide was 21·7 grains.

WEIGHTS AND MEASURES.

1 Sovereign weighs...	...	...	123·274 grains
1 Shilling " ...	...	...	87·273 "
48 Pence " ...	...	...	1 lb. avoirdupois
Half-penny and three-penny piece weigh...	...	...	$\frac{1}{4}$ ounce
Florin and sixpence " ...	...	...	$\frac{1}{2}$ "
Three pennies " ...	...	...	1 "
4 half-crowns and 1 shilling " ...	...	...	2 "
4 Florins, 4 half-crowns, 2 pennies ...	...	...	4 "
1 Half-penny = 1 inch in diameter			

AVOIRDUPOIS WEIGHT.

27 $\frac{11}{32}$ Grains ...	...	...	1 drachm (= 27 $\frac{11}{32}$ grs.)
16 Drachms ...	...	...	1 ounce (= 437 $\frac{1}{2}$ „)
16 Ounces ...	...	...	1 pound (= 7000 „)

TROY WEIGHT.

24 grains ...	...	...	1 pennyweight (= 24 grains)
20 pennyweights ...	...	...	1 ounce (= 480 „)
12 ounces... ..	...	...	1 pound (= 5760 „)

OLD APOTHECARIES' WEIGHT.

(Superseded in 1864).

20 Grains ...	...	...	1 scruple (= 20 grains)
3 Scruples ...	...	...	1 drachm (= 60 „)
8 Drachms ...	...	...	1 ounce (= 480 „)
12 Ounces ...	...	...	1 pound (= 5760 „)

The New Apothecaries' Weight is the same as Avoirdupois.

LIQUID MEASURE.

60 Minims ...	...	...	1 drachm
8 Drachms ...	...	...	1 ounce
20 Ounces ...	...	...	1 pint
8 Pints ...	...	...	1 gallon

The Imperial Gallon is exactly 10 lbs. Avoirdupois of pure water; the pint, 1 $\frac{1}{4}$ lbs.

DOCTOR'S FLUID MEASURE.

4 Gills = 1 Pint	=	34 $\frac{2}{3}$ cub. in. nearly
2 Pints = 1 Quart	=	69 $\frac{1}{3}$ „
4 Qrts. = 1 Gal.	=	277 $\frac{1}{4}$ „
1 Minim	=	1 drop
1 Drachm	=	1 teaspoonful
2 Drachms	=	1 dessert spoonful
4 „	=	1 table „

FRENCH WEIGHTS.

1 Gramme ...	15.432 grains
Kilogramme ...	1000 grammes (= 2.2 lbs. Avoir. nearly)

FRENCH FLUID MEASURE.

1 Litre ...	...	35.216 ounces (fluid)
1 Centimetre ...	...	17 minims nearly
50 Centimetres	1 ounce	6 drachms 5 minims

FRENCH LINEAR MEASURE.

1 Metre	39.37 inches
-------------	-----	--------------

TABLE SHOWING SP. GR. OF ABSOLUTE ALCOHOL WHEN COMBINED WITH VARYING QUANTITIES OF WATER AT 60° F.

Alcohol per cent.		Specific Gravity.	Alcohol per cent.		Specific Gravity.
50	...	·9228	85	...	·8357
55	...	·9068	86	...	·8331
60	...	·8956	87	...	·8305
65	...	·8840	88	...	·8279
68	...	·8769	89	...	·8254
70	...	·8721	90	...	·8228
72	...	·8672	91	...	·8199
74	...	·8625	92	...	·8172
76	...	·8581	93	...	·8145
78	...	·8533	94	...	·8118
79	...	·8508	95	...	·8089
80	...	·8483	96	...	·8061
81	...	·8459	97	...	·8031
82	...	·8434	98	...	·8001
83	...	·8408	99	...	·7969
84	...	·8382	100	...	·7938

TABLE OF THE SYMBOLS AND COMBINING WEIGHTS OF THE MOST COMMON ELEMENTS.

Name.	Symbol.	Comb. Weight	Name.	Symbol.	Comb. Weight.
Aluminium	Al	... 27·4	Lead	Pb	... 207
Antimony	Sb	... 122·0	Lithium	Li	... 7
Arsenic	As	... 75	Magnesium	Mg	... 24
Barium	Ba	... 137	Manganese	Mn	... 55
Bismuth	Bi	... 210	Mercury	Hg	... 200
Boron	B	... 11	Nickel	Ni	... 58·7
Bromine	Br	... 80	Nitrogen	N	... 14
Cadmium	Cd	... 112	Oxygen	O	... 16
Calcium	Ca	... 40	Palladium	Pd	... 106·6
Carbon	C	... 12	Phosphorus	P	... 31
Chlorine	Cl	... 35·5	Platinum	Pt	... 98·7
Chromium	Cr	... 52·2	Potassium	K	... 39·1
Cobalt	Co	... 59	Silicon	Si	... 28
Copper	Cu	... 63·5	Silver	Ag	... 108
Fluorine	F	... 19	Sodium	Na	... 23
Gold	Au	... 197	Strontium	Sr	... 87·5
Hydrogen	H	... 1	Sulphur	S	... 32
Iodine	I	... 127	Tin	Sn	... 118
Iridium	Ir	... 198	Uranium	U	... 120
Iron	Fe	... 56	Zinc	Zn	... 65·2

CHEMICAL COMPOUNDS TO WHICH REFERENCE IS MADE IN THE BOOK.

New Nomenclature.	Symbols.	Old Nomenclature
Ammonium bromide ...	$\text{NH}_4 \text{Br}$...	Bromide of ammonium
„ chloride ...	$\text{NH}_4 \text{Cl}$...	Chloride of ammonium
„ iodide ...	$\text{NH}_4 \text{I}$...	Iodide of ammonium
Barium nitrate ...	$\text{Ba} (\text{NO}_3)_2$...	Nitrate of baryta
„ sulphate ...	$\text{Ba} \text{SO}_4$...	Sulphate of baryta
Cadmium bromide ...	$\text{Cd} \text{Br}_2$...	Bromide of cadmium
„ chloride ...	$\text{Cd} \text{Cl}_2$...	Chloride of cadmium
„ iodide ...	$\text{Cd} \text{I}_2$...	Iodide of cadmium
Calcium chloride ...	$\text{Ca} \text{Cl}_2$...	Chloride of calcium
Copper chloride ...	$\text{Ca} \text{Cl}_2$...	Chloride of copper
Ferrie nitrate ...	$\text{Fe} (\text{NO}_3)_3$...	Pernitrate of iron
„ sulphate ...	$\text{Fe}_2 (\text{SO}_4)_3$...	Persulphate of iron
Ferrous nitrate ...	$\text{Fe} (\text{NO}_3)_2$...	Proto-nitrate of iron
„ sulphate ...	$\text{Fe} \text{SO}_4$...	Protosulphate of iron
Gold trichloride ...	$\text{Au} \text{Cl}_3$...	Terchloride of gold
Hydrogen sulphide ...	$\text{H}_2 \text{S}$...	Sulphuretted hydrogen
Iridium chloride ...	$\text{Ir} \text{Cl}_3$...	Chloride of iridium
Mercuric dichloride ...	$\text{Hg} \text{Cl}_2$...	Dichloride of mercury
Platinum tetrachloride ...	$\text{Pt} \text{Cl}_4$...	Dichloride of platinum
Potassium bromide ...	$\text{K} \text{Br}$...	Bromide of potassium
„ chloride ...	$\text{K} \text{Cl}$...	Chloride of potassium
„ iodide ...	$\text{K} \text{I}$...	Iodide of potassium
„ dichromate ...	$\text{K}_2 \text{Cr}_2 \text{O}_7$...	Bichromate of potash
„ permanganate ...	KMnO_4 ...	Permanganate of potash
Silver bromide ...	$\text{Ag} \text{Br}$...	Bromide of silver
„ chloride ...	$\text{Ag} \text{Cl}$...	Chloride of silver
„ iodide ...	$\text{Ag} \text{I}$...	Iodide of silver
„ oxide ...	$\text{Ag}_2 \text{O}$...	Oxide of silver
„ nitrate ...	$\text{Ag} \text{NO}_3$...	Nitrate of silver
„ sulphate ...	$\text{Ag}_2 \text{SO}_4$...	Sulphate of silver
Sulphuric acid ...	$\text{H}_2 \text{SO}_4$...	Sulphuric acid
Uranium nitrate ...	$\text{U} \text{SO}_4$...	Nitrate of uranium
Zinc iodide ...	$\text{Zn} \text{I}_2$...	Iodide of zinc
„ bromide ...	$\text{Zn} \text{Br}_2$...	Bromide of zinc
„ chloride ...	$\text{Zn} \text{Cl}_2$...	Chloride of zinc

ABSTRACT OF STORES REQUIRED FOR PHOTO-LITHOGRAPHY AND ZINCOGRAPHY.

Acid, hydrochloric	}	in stoppered	}	...	...	1	lb.
„ nitric				...	...	1	„
„ sulph.				...	...	1	„
Cloths, cheese ...	...	...	...	...	...	2	
Cotton waste ...	...	...	...	...	...
Eraser, metal, with box-wood handle				...	...	1	
„ with sheath ...	...	...	...	...	...	1	
Galls, bruised ...	...	...	...	...	...	1	„
Gum-arabic ...	...	...	...	...	...	$\frac{1}{2}$	„
Handles, leather, for rollers ...	...	...	...	...	...	1	pair
Ink, black, in tin ...	...	...	...	...	...	1	lb.
Knives, palette...	...	...	...	...	...	2	
Millboards (thickest) ...	...	...	...	...	...	10	lbs.
Mullers, zinc ...	...	...	...	...	...	2	
Oil, olive ...	...	...	...	...	...	$\frac{1}{2}$	pint
„ green ...	...	...	...	...	...	1	„
Plates, zinc (according to size of press, No. 10 guage)							
Press, lithographic ...	...	...	...	...	...
Roller, ordinary ...	...	...	...	...	...	1	
„ smooth...	...	...	...	...	...	1	
Sand moulders...	...	...	...	...	...	$\frac{1}{4}$	bsh.
Scrapers, box-wood, for press...	...	...	...	...	...	2	
Sieve, 120 hole ...	...	...	...	...	...	1	
Sponges ...	...	...	...	...	...	2	
Stone, pumice ...	...	...	...	...	...	4	lbs.
„ snake ...	...	...	...	...	...	2	„
Stone, litho., fine and free from chalk				...	...
Glaze boards ...	...	...	...	...	...	2	
Paper, glass ...	...	...	...	...	...	6	shts.
Phosphorus ...	...	...	...	...	...	1	oz.

KIT THAT MAY BE NECESSARY FOR ONE DAY'S WORK IN THE FIELD.

Camera.	Dusting Brush.
Dark Slides.	Developing Cups.
Camera Legs.	Plate Holder.
Lenses.	Emery Powder.
Focussing Cloth.	Tripoli Powder.
Do. Glass.	Spirits of Wine.
Glazier's Diamond.	Bath Solution.
Circular Spirit Level.	Collodion.
Tent.	Developer, 10 grs.
Water Bag and Clip.	Do., 50 „
Tent Legs.	Intensifier, Iron
Yellow Silk Handkerchief.	Do., Pyrogallic
Bath.	Silver Nitrate Solution,
Dipper.	20 grains.
Glass Plates.	Potassium Cyanide.
Plate Boxes.	Iodine Solution.
Funnel.	Tannin and Glycerine Solution.
Filter Paper.	Glacial Acetic Acid.
4-oz. Measure.	Golden Syrup Solution.
Cotton Wool.	Spirit Lamp.
Chamois Leather.	Bottle of Spirit.
Diaper Dusters.	Varnish.

KIT NECESSARY FOR WORKING THE COLLODION EMULSION PROCESS ON TOUR.

Emulsion.	Preservative.
Washed Cotton Wool.	Developing Materials.
Plates.	Sodium Hyposulphite in Bottle.
Small Funnel.	Gelatinized Paper for
Spare Bottle.	Transferring Films.
Two Dishes a little Larger than	Camera.
the Plate.	Legs.
Tripoli Powder.	Screws, &c.
French Chalk.	Focussing Cloth.
Gelatine or Albumen.	Duster.
Plates and Weights.	Box for Carrying Plates.
Screen for Candle.	2 Plate Holders.
Dusting Brush.	Dry Plate Box.
Ether and { Mixed two of Ether	Tray of India-rubber Sheeting.
Alcohol { to one of Alcohol.	Intensifying Solutions.

P. MEAGHER,

PHOTOGRAPHIC APPARATUS MANUFACTURER.

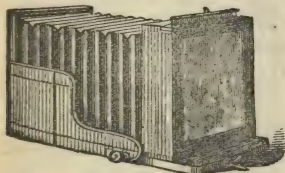
AWARDS. { *International Exhibition, 1862—HIGHEST AWARD*
Photographic Society of Scotland, 1863—ONLY MEDAL.
Berlin International Exhibition, 1865—MEDAL
North London Exhibition, 1865—ONLY PRIZE MEDAL
Dublin International Exhibition, 1865—HIGHEST AWARD
Paris Universal Exhibition, 1867—ONLY MEDAL FOR CAMERAS
Edinburgh Photographic Society, 1877—ONLY MEDAL FOR CAMERAS.

The above are the only Exhibitions where P. M. has been an Exhibitor; and the award of each Jury was for great excellence in design and manufacture of Cameras.

MEAGHER'S NEW FOLDING CAMERA.

This CAMERA is similar in construction to the already well-known Binocular Camera, and possesses the following advantages over the existing Landscape or Kinnear form of Camera:—No screws are required for fixing; the focussing is effected from the back by the screw adjustment; the focussing-screen is attached to the camera, and the bellows body is PARALLEL. This will be found of great advantage when using wide-angle lenses. It is available either for the studio or field, the range of focus permitting the use of the shortest-focus stereo lenses, or any of the Wide-angle, Doublet, or View Lenses, also for the C.D.V. or Cabinet Lenses.

"The Cameras of Meagher deserve especial examination, as well for the perfection of their workmanship as for their perfect adaptation to the purposes for which they are designed."—*Vide Report of Jurors, Class IX., International Exhibition, Paris, 1867, Illustrated London News, September 14, 1867, page 238.*
 "Of the Camera in its most improved form we cannot speak otherwise than in terms of unqualified praise."—*Vide The British Journal of Photography, March 8, 1867.*



This Camera is used in the Government Photographic Departments, and by nearly all the best Amateur and Professional Photographers; and has been adopted by nearly every Maker of, and Dealer in, Cameras, both at home and abroad. See the various Illustrated Catalogues.



These Cameras were selected by Captain Abney, R.E., F.R.S., for the Photographic Equipment of H.M.S. "Challenger," the American Boundary Commission, and the Arctic Expedition.

Prices for Pictures.		Single Swing-back extra.	Double Swing-back extra.	Brass Binding.	Russia-leather Bellows.
8½ by 6½	£5 16 0	£0 15 0	£1 10 0	£1 0 0	£0 18 0
8½ by 8½	6 10 0	0 15 0	1 10 0	1 0 0	0 18 0
9 by 7	6 6 0	0 15 0	1 10 0	1 0 0	0 18 0
9 by 9	6 16 0	0 15 0	1 10 0	1 0 0	0 18 0
10 by 8	6 16 0	1 0 0	2 0 0	1 5 0	1 1 0
10 by 10	7 10 0	1 0 0	2 0 0	1 5 0	1 1 0
12 by 10	8 0 0	1 5 0	2 10 0	1 10 0	1 7 0
12 by 12	8 15 0	1 5 0	2 10 0	1 10 0	1 7 0
15 by 12	10 0 0	1 10 0	3 0 0	2 0 0	1 17 6
15 by 15	11 10 0	1 10 0	3 0 0	2 0 0	1 17 6

The above prices include one Single Back and two Inner Frames.

If required for copying purposes, these Cameras are made with extending fronts, and can also be fitted with Repeating Back for two Cabinets and two C.D.V. pictures on one plate, thus meeting all the requirements of the practical photographer. For the larger sizes, above 8½×6½, the square form with swing back is recommended.

Extract from a letter from Mr. H. P. ROBINSON.—"I like your new camera very much; it is very perfect and complete." "I have never used a camera which has given me more satisfaction."—Mr. B. J. EDWARDS.
 "I am very much pleased with your new camera."—Dr. VOGEL, Berlin. "The camera I consider perfect."
 "It is a model of lightness and strength; in fact I cannot eulogise it too much."—Mr. E. DUNMORE.
 "The new camera is a splendid instrument perfect in every respect."—Messrs. SAWYER & BIRD. "I consider your new folding camera, with extending front, the most perfect instrument I have ever used."—Mr. J. VALENTINE, Dundee.

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Mounts for Views or Large Portraits, White or Toned, with or without Oxford Line, in any colour.

Cut-out Mounts for all sizes, White or Toned. Cases for Cartes-de-Visite, with Name and Address embossed thereon. Passepartouts, Maroon and Flock Mounts, Albums, &c.

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ROUCH'S PATENT PORTABLE CAMERA.

The Lightness of this Camera is unsurpassed; it is confidently recommended as the very best for Dry Plate work. Its bulk, when packed, is reduced to a minimum, while its portability and firmness are equal to even the heaviest and most cumbersome Cameras. It is manufactured in the following sizes:—

		Price, with one Wet Collodion Back for Plates.				Double Backs for Dry Plates.	
						Each	£1 2 0
$6\frac{1}{2} \times 4\frac{3}{4}$	£4	4	0	...	1 3 6
$7\frac{1}{2} \times 5$	4	10	0	...	1 7 0
$8\frac{1}{2} \times 6\frac{1}{2}$	4	17	6	...	1 12 0
10×8	5	10	0	...	2 0 0
12×10	6	10	0	...	

Light flexible Sling Cases, made of Waterproof Mail Cloth, to hold Camera and three Double Backs, at prices from 14s. to 25s.

BEECHEY DRY PLATES, as now prepared by us, are wonderful as regards sensitiveness; their certainty is undoubted, and the quality of Negative the same as Wet Collodion.

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Ditto ditto for Plates, size 5×4 , £9.

ROUCH'S NEW NEGATIVE COLLODION (1878).—The demand for this preparation is now so great as to justify the assertion that it is the Best Collodion for Landscapes, Portraits, and Enlargements, while in keeping qualities it excels all other makes. Price, per Pint, 7s. 6d.; Six Pints, 42s.

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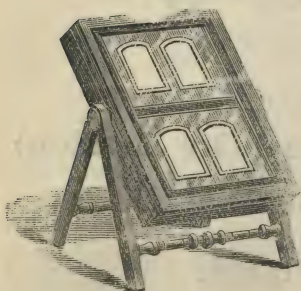
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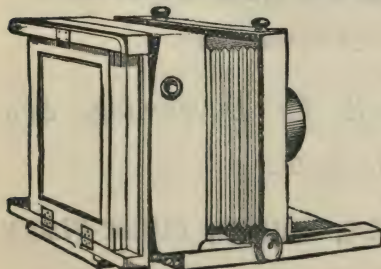


This Instrument has been much admired wherever exhibited. It is simple in construction, and suitable alike for the Drawing Room and Photographic Reception Room. It will hold 52 Cartes or 26 Portraits or Views.

Prices from £2 2s.

Extract from the TABLET:—"All who have Albums (and who have not?) must have regretted their dilapidation and the deterioration of the Cartes. The New Revolving Album of Mr. G. HARE, 26, Calthorpe Street, will therefore be welcomed as effective for preservation, and ingenious and simple in construction."

THE UNIVERSAL CAMERA FOR THE STUDIO.



Introduced by G. HARE, in 1864, still maintains its reputation as the best Studio Camera yet devised. It is adapted for single or double Carte-de-Visite, for Half or Whole-plate Portraits, for the New Cabinet Pictures, either single or two on the same plate.

It possesses so many advantages that no other Camera is necessary in the Studio. The best proof of its value and usefulness is shown in the extent to which it has been copied by other makers.

PRICES, with one Single Slide, two Inner Frames, and Focussing Screen:

	6½ in. square.	8½ in.	9 in.	10 in.
For Plates	6½ × 4½	8½ × 6½	9 × 7	10 × 8
Swinging Back	£5 15 0	£7 0 0	£7 10 0	£8 10 0
Double Swing	6 15 0	8 0 0	8 10 0	9 12 0

Backwork fitted to Swinging Back from 10s. each swing.

R. KENNETT'S NEW SLIDING CAMERA STAND

Is made in three sizes, price 26s.

G. HARE'S PATENT AUTOMATIC CHANGING-BOX.

By means of this apparatus a sensitive plate can be transferred from the plate-box to the camera with the greatest facility, and without the possibility of its being affected by light. Holding a dozen, or as many more plates as may be desired, it is so arranged that any one of the collection may be removed, exposed in the camera, and transferred to its own place again with absolute certainty. The plates are inserted at the bottom, which is a light-tight slide.

THE PRICE OF BOX TO HOLD TWELVE PLATES AND DARK SLIDE—

5 by 4	- £3 15 0	8 by 5	- £4 10 0	10 by 8	- £5 15 0
7½ by 4½	- 4 4 0	8½ by 6½	- 5 0 0	12 by 10	- 6 10 0

A small extra charge is made if more than twelve plates are required in the box.

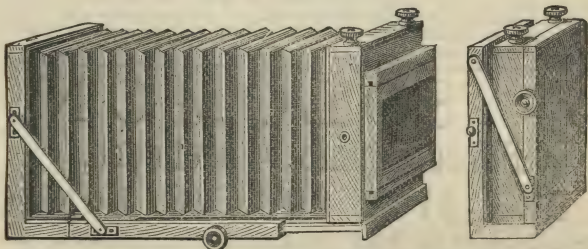
Brass Binding ditto, for India or Hot Climates, from 12s.

Leather Cases for holding Box and Slide, from 15s. each.

A Medal was awarded to G. Hare's Patent Automatic Changing-Box and Binocular Camera, new arrangement, at the Belgian Photographic Society's Exhibition, 1875.

IMPROVED PORTABLE BELLOWS CAMERA.

NEW ARRANGEMENT.



This Camera is exceedingly simple in design, can be easily set up and taken down, is perfectly rigid and steady when in use. It has double swinging back. After the camera has been drawn out to its fullest extent and clamped, it can then, by means of screw or rack adjustment, be extended two-thirds of the length of the base-board more, thus giving a range of focus for a 7½ by 5 Camera from 2¾ inches to 16½ inches. The Dark Slide can be made the size of plate for the Square Camera; this, fitting in grooved guides or runners on a frame, can be placed either in a vertical or horizontal position. This is of great advantage, and recommended when Dry Plates are going to be used; if for Wet Plates only, the Square Slide is to be preferred.

Prices, with one Single Back, two Inner Frames, and Focussing Screen:—

For Plates.	Horizontal and Vertical.	Square.	Brass Binding.
7½ × 4½	... £6 5 0	... £7 5 0	... £1 0 0
8 × 5	... 6 15 0	... 7 15 0	... 1 0 0
8½ × 6½	... 7 15 0	... 8 15 0	... 1 0 0
10 × 8	... 9 5 0	... 10 5 0	... 1 5 0
12 × 10	... 10 10 0	... 11 10 0	... 1 10 0
15 × 12	... 13 0 0	... 14 10 0	... 2 0 0

Illustrated Price List on Application at the Manufactory, 26, Calthorpe Street, Gray's Inn Road, W.C.

G. HARE, 26, Calthorpe Street, Gray's Inn Road, London.

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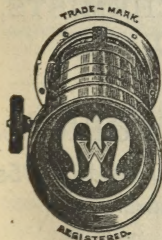
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
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